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Reducing Chemical Fertilizers Partially by using Natural Alternative Sources of Organic Fertilizers and its Impact on "Hass" Avocado Trees

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Abstract

This research was conducted on avocado trees (*Persea americana*, Mill.) "Hass" cv. during 2020/2021 seasons in a private orchard located at El-Nubaria region, El-Beheira Governorate, Egypt. It was an attempt to substitute chemical fertilizers (**CF**) such as N, P, K and Mg with organic fertilizers such as compost (**COM**) and natural fertilizer sources (**NFS**) followed by a study of its impact on vegetative growth, yield, fruit quality, and nutritional status. Organic fertilizer was used alone or in combination with CF to fulfill the requirements of each tree. It contains an identical amount of compost (20 kg/tree) in combination with four levels of NFS to cover 100%, 75%, 50% and 25% of the tree's requirements. Considering that, the natural fertilizer sources (**NFS**) were granulated organic N fertilizer and natural raw rocky materials for P, K and Mg. The previous treatments were compared with 100% mineral recommended doses of N, P, K and Mg (control). Results indicated that mineral fertilization significantly improved values of all tested properties compared with all treatments in both seasons of the study with no significant differences between it and 50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF** treatment in the 2nd season with regard to the following traits (shoot length, shoot number/branch, fruit weight and pulp weight).

Keywords: *Avocado, Hass, Growth, yield, Fruit quality and Nutritional status.*

1. Introduction

Avocado (*Persea americana*, Mill) is a native American tropical fruit. It belongs to the family Lauraceae. It has developed into three horticultural races (West Indian, Guatemalan and Mexican [1], which are adaptable to a wide range of soil and climatic conditions [2]. Also, genus *Persea* constitutes of 150 species out of which 70 are grown in the warmer regions of north central and South America. Its other entire species are cultivated in east and south East Asia [3]. In addition, Due to its excellent nutritional value (high amount of high-density lipoprotein, folic acid, potassium, Vitamins A, B, C, D, and E), as well as its therapeutic characteristics, it has been traditionally cultivated for nutritional and medical uses [4, 5]. Avocado has earned international prominence and a substantial amount of trade. Despite its novelty in international trade, this unique fruit has been valued and used for at least 9000 years mostly around its Meso-American origins [6]. In 2020, world production of avocados was 8 million tons, with Mexico alone accounting for 29.7% (2.4 million tons) of the total production [7]. Avocado was only grown in a few spots in El-Delta region, in the 50s and 60s of the previous centuries. Only one or two cultivars were grown in these areas but recently new areas as New Nubaria, Ismailia and El-Khatatba started to be grown with avocado cultivars i.e. Hass, Fuerte, Red and Bacon.

Hass is the world's most important avocado cultivar, with several characteristics that make it a favorite among growers, merchants, and consumers. In addition, the superior flavor and high demand firmly put Hass in its place as a luxury fruit. The fruit takes an oval shape, thick, pebbly skin that darkens when ripe [8, 9].

Fertilization is one of the most important practices for increasing vegetative growth, productivity and fruit quality of fruit trees. Chemical fertilizers (**CF**) are used to counteract low soil fertility, which makes orchard management more expensive and pollutes the environment. As a result, farmer producers should be

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tending to use natural alternative fertilizers instead of **CF**, which lead to improve production and access to safe fruits for local consumer and high exportation potential as well as reduce the costs [10, 11]. Hence, using organic fertilizer sources such as compost and natural alternative rocks (elements in a raw form) is considered as the perfect and safe solution to improve physical, chemical and biological properties of nearly all soil types, adjusting soil pH and increasing solubility production of the plants [12, 13]. The addition of organic fertilizer to the soil encouraged proliferation of soil microorganisms, increased microbial population and activity of microbial enzymes i.e. dehydrogenize, urease and nitrogenase [14, 15].

Based on the most important and recent literature data on organic fertilization for the fruit trees nutrition, the purpose of this research is studying the effect of replacing **CF** (N, P, K and Mg) by an alternative cheaper and ecologically friendly ones on vegetative growth, yield, fruit quality and nutritional status of "Hass" avocado trees.

2. Materials and methods

The research was carried out during two successive seasons (2020 and 2021) on 20-years old avocado trees (*Persea americana*, Mill.) Hass cv. grown on sandy soil at 6.5×6.5 meters apart (Approximately 100 trees/fed) under drip irrigation system in a private orchard located at New Nubaria, El-Beheira Governorate, Egypt. The physical and chemical properties of the experimental soil are presented in Table 1*. The chosen trees were uniform in their vigor, size, shape and disease free. Trees were subjected to five treatments with three replicates per each and each replicate contains 3 trees (5 treatments × 3 replicates × 3 trees = 45 trees). Treatments were arranged in a randomized complete block design (**RCBD**).

Table 1 Physical and chemical analysis of the investigated soil

Characters	Value	Characters	Value
Particle size distribution		**Macro and micro nutrients**	
Clay %	5.00	N %	1.5
Silt %	2.00	P %	0.8
Sand %	90	K %	1.2
Texture	Sand	Ca (mg/L)	2.65
EC (mmhos cm^{-1})	1.50	Mg (mg/L)	2.40
pH	8.65	Fe (ppm)	1.00
Organic matter %	0.13	Zn (ppm)	1.20
Total carbonate %	2.00	Cu (ppm)	2.30

The chosen trees received the whole normal cultural practices. Chemical fertilizers doses (**CF**) were added through drip irrigation system during the two seasons of the study. The plants were received **CF** at the recommended doses of N, P, K and Mg (3.6Kg ammonium nitrate 33.5% N, 0.5Kg phosphoric acid 85% P_2O_5, 1.5Kg potassium sulphate 48% K_2O and 2.8Kg Magnesium sulphate 16% $MgSO_4$ /tree/year).

On the other hand, organic fertilizers were applied to the soil in winter (the 2nd week of December) in both seasons of the study, either alone or in conjunction with CF, to fulfill the demand of each tree. Organic fertilizer was consisting of the same dose of COM** (20 kg/tree/year), it was applied to organic treatments on both sides of the tree in combination with four levels of natural fertilizer sources (NFS) to cover 100, 75, 50, and 25% of the tree's requirements.

Natural fertilizer sources (**NFS**) of organic fertilizers contains granulated organic N fertilizer of 20% actual N***, rock phosphate (granulated natural mineral rocky material P source of 18% actual P_2O_5***), feldspar (granulated natural mineral rocky material K source of 12% actual K_2O***) and dolomite (granulated natural mineral rocky material of Mg source of 12% actual $Mg(CO_3)_2$***. The treatments were described as follow:

- T_1. Control: 100% recommended doses of N, P, K and Mg (**CF**)
- T_2. 100% organic fertilizer (20kg **COM** + **NFS**)
- T_3. 75% organic fertilizer (20kg **COM** + **NFS**) + 25% **CF**
- T_4. 50% organic fertilizer (20kg **COM** + **NFS**) + 50% **CF**
- T_5. 25% organic fertilizer (20kg **COM** + **NFS**) + 75% **CF**

***** An annual analysis of the soil is advisable to guarantee that the percentage of the elements is in the safe limits.

****** The chemical composition of the tested compost is shown in Table 2.

******* Prepared, purified and salad by AL AHRAM MINING COMPANY.

Table 2 Physical and chemical analysis of the compost

Analysis	Value	Analysis	Value
M^3 weight	792 kg	P %	0.3
Moisture %	31	K %	1
PH (1:10)	8.9	Ca %	1.8
EC (ds/m)	3.41	Mg %	0.9
Organic matter	35.6	Fe (ppm)	1012
C/N ratio	17.6	Mn (ppm)	116
Organic carbon %	26.4	Zn (ppm)	28
Total N %	1.8	Cu (ppm)	17.90

Measurements

Vegetative growth parameters

In the 1st week of September in both seasons the following parameters are measured:

- Shoot length (cm)
- Number of shoots per branch
- Number of leaves per shoot
- Canopy volume of trees (m^3) was measured which tree shape was considered as one-half of a probate sphere (volume = $4/6 \times \pi \times height \times radius^2$, $\pi = 22/7$) as described by Roose *et al.* [16].
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Leaves chemical analysis

Furthermore, in the 1st week of September in both seasons of the study, 20 six-month-old spring flush leaves from non-fruiting terminals shoots were collected uniformly around each tree [17] and total Chlorophyll ($mg.g^{-1}$) was calorimetrically determined in leaves samples according to Saric *et al.* [18]. Then, leaf sample was washed by tap water then with distilled water and dried using oven at 70°C to a constant weight according to Chapman and Pratt [19] then grounded and subjected to the following nutritional status determinations:

- Nitrogen was measured by semi-micro Kjeldahl as percentage described by Plummer [20].
- Phosphorus was determined using a spectrophotometer as percentage by the method outlined by Jackson [21].
- Potassium and calcium were determined by a flame photometer Jenway PFP7 as percentage according to method of Jackson [22].
- Magnesium as percentage and iron, manganese, zinc and copper as ppm were determined using atomic absorption spectrophotometer Perkin Elmer 1100 [23].
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Yield, fruit physical parameters and fruit quality

At the 1st week of September, as soon as the harvest maturity indicators appeared on the fruits as described by Rodriguez *et al.* [24], twenty-seven fruits from each treatment (nine fruits per replicate) were collected and transferred to laboratory to measure and determine the following parameters:

Yield and fruit physical parameters

- Fruits number per tree, fruit weight (g), seed weight (g) and pulp weight (g) were determined.
- Yield per tree (Kg) = fruits number per tree × fruit weight

Fruit quality parameter

- Total soluble solids percentage (**TSS** Brix %) determined by Carl Zeiss hand refractometer
- Total acidity was determined based on linoleic acid, a predominant acid in avocados, as used by Maftoonazad and Ramaswamy [25].
- Vitamin C. was expressed as mg ascorbic acid per 100 ml juice according to AOAC [26].

Statistical analysis

The data obtained in each season were analyzed by ANOVA according to Snedecor and Cochran[27]. Means were separated by Duncan [28] and multiple range test using a significance level of $P < 0.05$.

3. Results

Vegetative growth parameters

It is evident from the results in Table 3 that highest effect of fertilization treatments on all of the considered vegetative growth parameters i.e. shoot length, number of shoots/branch and number of leaves/shoot were attributed to the T_1 control treatment **(CF)** in the 1st season of the study which gave 26.14cm, 6 and 16 followed by T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) which gave 24.27cm, 5 and 13 shoot length, number of shoots/branch and number of leaves/shoot respectively. However, in the 2nd season no significant differences were observed between T_1 (**CF**) and T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) regarding the shoot length and number of shoots/branch. In this respect, T_1 (**CF**) recorded 26.58cm and 6.66 while, T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) gave 26.55cm and 6.33 for shoot length and number of shoots/branch respectively. On the other hand, T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest values on all vegetative parameters in both seasons of the study. Concerning canopy volume parameter the results show that, no significant differences between all treatments and the control treatment in both seasons of the study.

Leaves chemical analysis

Total Chlorophyll ($mg.g^{-1}$)

Results presented in Table 4 show that, T_1 (**CF**) was superior in comparison with organic treatments which gave 1.93 and 1.95 $mg.g^{-1}$ in both seasons of the study, respectively. However, T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest value of total chlorophyll in leaves (1.60 and1.70 $mg.g^{-1}$) in the 1st and the 2nd seasons, respectively. The rest of treatments were in between without any significant differences among all of them.

Leaves Macro and Micro Elements Content

Table 4 showed leaf macro and micro elements content of "Hass" avocado trees as affected by organic fertilization.

Table 3 Effect of natural fertilizer sources on vegetative growth parameters of Hass avocado cultivar

Parameters / Treatments		Shoot length (cm)		Number of shoots /branch		Number of leaves /shoot		Canopy volume (m^3)	
		2020	2021	2020	2021	2020	2021	2020	2021
T_1	Control (100% NPK Chemical) CF	26.14 a	26.58 a	6.00 a	6.66 a	16.00 a	17.33 a	76.00 a	77.67 a
T_2	100% organic fertilizer (20kg COM + NFS)	17.58 d	18.08 c	1.33 d	2.00 c	7.00 d	7.40 d	74.67 a	75.17 a
T_3	75% organic fertilizer (20kg COM + NFS) + 25% CF	18.08 d	18.75 c	1.33 d	2.33 c	10.00 c	10.66 c	74.00 a	75.20 a
T_4	50% organic fertilizer (20kg COM + NFS) + 50% CF	24.27 b	26.55 a	5.00 b	6.33 a	13.00 b	15.33 b	75.17 a	76.67 a
T_5	25% organic fertilizer (20kg COM + NFS) + 75% CF	22.92 c	24.08 b	3.00 c	4.66 b	11.00 c	12.33 c	75.33 a	76.00 a

Mean separation within each column by Duncan Multiple Range (0.05). Means with similar letters are insignificantly different.

Table 4 Effect of natural fertilizer sources on leaves content of chlorophyll and macro-nutrients of Hass avocado cultivar

Parameters / Treatments		Chlorophyll ($mg.g^{-1}$)		N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1	Control (100% NPK Chemical) CF	1.93 a	1.95 a	1.97 a	1.99 a	0.19 a	0.19 a	1.73 a	1.75 a	2.41 a	2.46 a	0.61 a	0.62 a
T_2	100% organic fertilizer (20kg COM + NFS)	1.60 c	1.70 c	1.72 c	1.81 c	0.09 c	0.11 d	1.50 c	1.57 c	1.65 d	2.00 d	0.44 d	0.50 b
T_3	75% organic fertilizer (20kg COM + NFS) + 25% CF	1.65 b	1.79 b	1.74 c	1.86 b	0.11 bc	0.13 c	1.60 b	1.62 b	1.75 c	2.30 c	0.50 c	0.53 b
T_4	50% organic fertilizer (20kg COM + NFS) + 50% CF	1.69 b	1.83 b	1.81 b	1.94 a	0.13 b	0.17 b	1.63 b	1.73 a	1.84 b	2.41 ab	0.55 b	0.61 a
T_5	25% organic fertilizer (20kg COM + NFS) + 75% CF	1.68 b	1.83 b	1.79 b	1.89 b	0.12 b	0.16 b	1.62 b	1.72 a	1.82 b	2.35 bc	0.53 b	0.58 a

Mean separation within each column by Duncan Multiple Range (0.05). Means with similar letters are insignificantly different.

- **Leaves macro elements content (%)**

Leaf nitrogen content was significantly affected by different treatments in both seasons of the study. T_1 (**CF**) and T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) recorded the highest nitrogen content in leaves in both seasons of the study (1.97 and 1.99% for T_1 and 1.81 and 1.94% for T_4) without any significant differences between them in the 2nd season.

Concerning phosphorus content in leaves, results indicated that, T_1 (**CF**) had a significant effect on phosphorus percentage in leaves compared with all other treatments which gave 0.19% in both seasons of the study. Followed by T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) and T_5 (25% organic fertilizer (20kg **COM**+**NFS**) + 75% **CF**)) in both seasons of the study.

When we transfer to potassium content in leaves, T_1 (**CF**) gave the highest K% content in the leaves (1.73 and1.75%) in both seasons, respectively. No significant difference between T_1 (**CF**) and T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) and T_5 (25% organic fertilizer (20kg **COM**+**NFS**) + 75% **CF**)) in the 2nd season.

In addition, treated trees with T_1 (**CF**) recorded the best percentage of leaf calcium content (2.41 and 2.46%) in the 1st and the 2nd seasons, but it had no significant differences with trees treated with T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)). Also, there were no significant differences between T_4 (50% organic fertilizer (20kg

COM+**NFS**) + 50% **CF**)) and T_5 (25% organic fertilizer (20kg **COM**+**NFS**) + 75% **CF**)) on the one hand and between T_5 (25% organic fertilizer (20kg **COM**+**NFS**) + 75% **CF**)) and T_3 (75% organic fertilizer (20kg **COM**+**NFS**) + 25% **CF**) on the other hand.

Magnesium percentage in leaves was significantly affected by all treatments, whereas T_1 (**CF**) gave the highest leaf content of Mg% (0.61 and 0.62%) in the 1st and the 2nd seasons, respectively. An absence of significant differences was recorded between T_1 (**CF**) and both of T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) and T_5 (25% organic fertilizer (20kg **COM**+**NFS**) + 75% **CF**)) in the 2nd season.

In general, T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest values of all macro nutrients content in leaves.

- **Leaves micro elements content (ppm)**

Table 5 shows that leaves content of Fe, Mn, Zn and Cu were significantly affected by different treatments in the two experimental seasons, and T_1 (**CF**) was superior in this respect. However, no significant differences were illustrated between T_1 (**CF**) and T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) concerning Fe, Mn and Cu in the 2nd season. T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest values of leaf content of Fe, Mn, Zn and Cu in this point.

Yield and fruit physical parameters

Results in Table 6 clearly show that, applying organic fertilizers of N, P, K and Mg, couldn't get over the effect of T_1 (**CF**) in both seasons of the study concerning yield/tree and some fruit physical parameters i.e. number of fruits/tree and seed weight. This gave 130 and 128 for the number of fruits/tree, 45.4 and 44.0 Kg for yield/tree. Regarding fruit weight and pulp weight T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) gave the highest value of fruit weight (349.3 and 346.7 g) and pulp weight (317.0 and 316.3 g) in the 1st and 2nd seasons respectively, Followed by T_1 (**CF**). However, T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest values of yield and fruit physical parameters in both seasons of the study. The rest of the treatments were in between.

Fruit quality parameters

It is obvious from the results in Table 7 the effect of mineral fertilizers and organic fertilizers of N, P, K and Mg on fruit TSS, acidity and vitamin C of Hass avocado in 2020 and 2021 seasons, which T_1 (**CF**) had a superior effect in this respect in comparison with natural fertilizer treatments. It gave 9.50 and 9.67% for TSS, 1.05 and 1.02% for acidity and 10.68 and 10.74 mg.100g^{-1} for vitamin C in the 1st and 2nd seasons, respectively. Followed by T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) which recorded 8.51 and 8.68% for TSS, 0.95 and 0.92% for acidity and 8.03 and 9.83 mg.100g^{-1} for vitamin C in the 1st and 2nd seasons, respectively. However, T_2 (100% organic fertilizer (20kg **COM**+**NFS**)) gave the lowest values of fruit quality parameters in both seasons of the study. The rest of the treatments occupied a middle rank between them.

4. Discussion

Continuous use of chemical fertilization contributes to the degradation of soil characteristics, fertility, deposition of heavy metals in plant tissues, affecting the nutritional value and edibility of the fruit [29]. There is a general agreement that nutrition is one of the most effective factors affecting vegetative growth, yield, and fruit quality, [30], however, the high cost of mineral fertilization is a major problem affecting fruit tree growers. In addition, a new research studies have shown that chemical fertilization has a role to play in health issues and environmental degradation. Besides, agricultural land is impoverished and high doses of agrochemicals need to be introduced, which greatly pollute the environment in the long run [31].

Hence, organic fertilization has a positive effect in this respect, because it improves the physical, chemical and biological properties of all soil forms, changes soil pH, increases soil solubility and plant output. Furthermore, applying organic fertilizers not only increases the organic matter in the soil but also increases the available phosphorus and the exchangeable potassium, calcium and other micro-elements by affecting soil pH, promotes the propagation of soil microorganisms, raises the microbial community and the activity of microbial enzymes [32, 33]. Also, compost-based therapies can protect against the emergence of plant diseases and/or promote improved plant physiological status by improving the quantity and quality of crop production [34]. The obtained results show that, using organic fertilization in addition with mineral fertilization T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) has a positive effect on vegetative growth parameters, chlorophyll and nutritional status. These results are in a line with those obtained by Abd-Rabou [35] on avocado, Ennab *et al.* [36] and EL-Khwaga *et al.* [37] on Washington Navel orange, Barakat *et al.* [38] and Vazquez-Ovando and Andrino-Lopez [39] on Williams and Grande Naine banana, Peralta-Antonio *et al.* [40] on mango, Abou El-Khashab [41] on olive, El-Shenawy and Fayed [42] on *Crimson seedless* grapevines, Zhang *et al.* [43] and Milošević and Milošević [44] on apple, Mohamed *et al.* [45] and Eissa *et al.* [46] on Le-Conte pear trees, Fayed *et al.* [47] on peach and, Stino *et al.* [48] and Milošević *et al.* [49] on apricot.

Table 5 Effect of natural fertilizer sources on leaves content of micro-nutrients of Hass avocado cultivar

Parameters / Treatments		Fe (ppm)		Mn (ppm)		Zn (ppm)		Cu (ppm)	
		2020	2021	2020	2021	2020	2021	2020	2021
T_1	Control (100% NPK Chemical) CF	72.80 a	73.33 a	135.00 a	136.00 a	118.50 a	119.33 a	47.50 a	48.33 a
T_2	100% organic fertilizer (20kg COM + NFS)	58.40 d	62.00 d	115.00 d	120.67 c	92.50 d	100.67 d	37.40 d	40.33 c
T_3	75% organic fertilizer (20kg COM + NFS) + 25% CF	61.33 c	66.00 c	121.50 c	130.50 b	103.54 c	108.00 c	39.50 c	41.67 c
T_4	50% organic fertilizer (20kg COM + NFS) + 50% CF	65.50 b	71.67 ab	127.00 b	135.00 a	108.00 b	114.33 b	41.50 b	47.00 ab
T_5	25% organic fertilizer (20kg COM + NFS) + 75% CF	64.00 b	69.00 bc	125.00 b	134.50 ab	105.00 c	110.67 bc	40.80 bc	45.33 b

Mean separation within each column by Duncan Multiple Range (0.05). Means with similar letters are insignificantly different.

Table 6 Effect of natural fertilizer sources on yield and fruit physical parameters of Hass avocado cultivar

Parameters / Treatments		Number of fruit /tree		Fruit weight (g)		Yield/tree (kg)		Seed weight (g)		Pulp weight (g)	
		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1	Control (100% NPK Chemical) CF	130 a	128 a	348.3 a	343.0 b	45.4 a	44.0 a	35.2 a	33.6 a	313.2 b	309.4 b
T_2	100% organic fertilizer (20kg COM + NFS)	71 e	70 e	222.3 d	216.0 e	15.8 e	15.0 e	28.4 d	26.2 d	193.9 e	189.8 e
T_3	75% organic fertilizer (20kg COM + NFS) + 25% CF	86 d	86 d	250.7 b	246.0 c	21.5 d	21.0 d	28.8 d	26.3 d	221.9 c	219.7 c
T_4	50% organic fertilizer (20kg COM + NFS) + 50% CF	115 b	109 b	349.3 a	346.7 a	40.2 b	38.0 b	32.3 b	30.3 b	317.0 a	316.3 a
T_5	25% organic fertilizer (20kg COM + NFS) + 75% CF	110 c	103 c	245.0 c	242.0 d	27.0 c	25.0 c	30.5 c	28.0 c	214.5 d	214.0 d

Mean separation within each column by Duncan Multiple Range (0.05). Means with similar letters are insignificantly different.

Table 7 Effect of natural fertilizer sources on fruit quality parameters of Hass avocado cultivar

Parameters / Treatments		TSS (%)		Acidity (%)		Vitamin C ($mg.100g^{-1}$)	
		2020	2021	2020	2021	2020	2021
T_1	Control (100% NPK Chemical) CF	9.50 a	9.67 a	1.05 a	1.02 a	10.68 a	10.74 a
T_2	100% organic fertilizer (20kg COM + NFS)	6.00 d	6.25 d	0.56 e	0.56 d	6.61 d	7.19 e
T_3	75% organic fertilizer (20kg COM + NFS) + 25% CF	7.33 c	7.50 c	0.73 d	0.72 c	6.83 d	7.83 d
T_4	50% organic fertilizer (20kg COM + NFS) + 50% CF	8.51 b	8.68 b	0.95 b	0.92 b	8.03 b	9.83 b
T_5	25% organic fertilizer (20kg COM + NFS) + 75% CF	7.75 bc	7.83 c	0.81 c	0.76 c	7.20 c	8.48 c

Mean separation within each column by Duncan Multiple Range (0.05). Means with similar letters are insignificantly different.

The advancing effect of long-term use of optimum level of organic fertilizers T_4 (50% organic fertilizer (20kg **COM**+**NFS**) + 50% **CF**)) could give a logical explanation for its positive action on physiochemical parameters of the fruits. Because of the high availability of nutrients as a result of employing organic fertilizers, cell division and cell expansion, as well as natural hormones, may be stimulated, resulting in larger fruits [50]. These results coincide well with those obtained by Abd-Rabou [35] on avocado, EL-Khwaga *et al.* [37] and El-Gioushy *et al.* [51] on Washington Navel orange trees, Fikry *et al.* [52] on Murcott Tangerine trees, Osman *et al.* [53] and Salama *et al.* [54] on Bartamuda and Hayany date palms, Baiea *et al.* [55] on Grande Naine banana, Peralta-Antonio *et al.* [40] and El-Gioushy *et al.* [56] on mango trees, Abou El-Khashab [41] on olive, El-Gioushy [57] and Baiea *et al.* [58] on Manfalouty and Wonderful pomegranate trees, Osman and Abd El-Rhman [59] on fig trees, Zhao *et al.* [60], Mekawy and Abd El-Hafeez [61] and El-Salhy *et al.* [62] on grapevines, Milošević and Milošević [44] on apple, Fayed *et al.* [47] on peach and El-Naggar [63] and EL-Gioushy and Baiea [64] on Canino apricot trees.

5. Conclusions

From the above-mentioned results, it could be concluded that, although chemical fertilization was superior in the 1st season more than other treatments. However, in the 2nd season some of vegetative growth and fruit physical characteristics were starting to appear a great improving due to replacing chemical fertilization (100% mineral N, P, K and Mg form) partially through using a combination between organic fertilizers equivalent to (50% organic fertilizer (20kg **COM**+**NFS**)) and chemical fertilizers (50% **CF**) for long-term to get good results.

6. List of abbreviations

Chemical fertilizers: **CF**, Compost: **COM**, Natural fertilizer sources: **NFS**, Randomized Complete Block Design: **RCBD** and Total Soluble Solids: **TSS**.

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