

EFFECT OF ENRICHED COMPOST TEA ON WASHINGTON NAVEL ORANGE TREES

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ABSTRACT

The present investigation was conducted during 2007 and 2008 seasons to study the effect of compost tea on vegetative growth, fruiting and yield, leaf mineral content and fruit quality of Washington navel orange trees.

All tested treatments gave generally significant increase on shoot length, leaves number/shoot and leaf surface area in both seasons of the study as compared with control, while T6 (20L compost tea at five equal doses in mid each February, March, April, June and August) gave the highest significant increase of shoot length, leaf number/shoot and relatively leaf surface area (14.02-14.25 cm) (7.22-7.72 leaf) (18.74-17.54cm²) in 2007 and 2008 seasons, respectively. In addition, T6 treatment relatively gave significant increase in fruits number and yield /tree (397.81-225.25 fruit and 94.84-55.10 Kg/tree, in both seasons, respectively. Moreover T6 gave significant increase in leaf content of nitrogen, phosphorus and potassium in both seasons of the study compared with control (2.99-3.08%, 0.276-0.288% and 1.98-2.02% in 2007 and 2008 seasons, respectively).

Concerning to nitrate and nitrite concentration in the fruit juice, T6 resulted in the lowest values of both compounds (4.42-4.64 and 0.087-0.091 ppm/100ml) in 2007 and 2008 seasons, respectively).

INTRODUCTION

Citrus is one of the most important fruit crops in the world and ranked the second order after Grapes. In Egypt, citrus are considered the first fruit crop trees either in total production or planting area. The total area of citrus cultivation was 165786 hectare that yielded about 3134174 metric ton according to the statistics of the Ministry of Agriculture, Egypt in (2007).

Navel Washington orange is considered one important cultivation of citrus that spread in worldwide and Egypt, where occupied (35%) from the total area of citrus in Egypt. Also, it is very important in exportation, therefore many countries need a certain characteristics in the fruits of orange, which included the best chemical properties especially in nitrite contents. The application of organic fertilizers in citrus orchard considered a production system which avoids or largely excludes the use of synthetic chemical fertilizers also using organic fertilizers produces safety fruits with minimum concentration of both nitrate nitrite.

Compost tea is a very important source of nutrients, organic matter and organisms. It can be used to fertilize many crops via soil or foliar applications, inoculate crop residue to facilitate decomposition, improve nutrient cycling in soil through increase microorganisms activity and manage certain plant pathogens, to some extent, through microbial competition and eventually improve plant nutrition.

Gamal and Ragab (2003) on 19-years-old Balady mandarin trees budded on sour orange rootstocks in 2001 and 2002 seasons and grown in sandy soil, studied the effect of both inorganic nitrogen fertilizers (ammonium sulfate 20.5%) and organic nitrogen (chicken manure 1.5% N and farmyard manure 0.72% N). treatments were as inorganic: organic N fertilizer ratios, 100:0, 75:25, 50:50, 25:75 and 0:100%. All trees received N at the recommended rate (750 g N/tree). They concluded that combination of inorganic and organic fertilizers application increased leaf surface area/shoot compared to either inorganic or organic fertilizers alone. The best results were obtained when farmyard manure at 52 kg/tree + inorganic N at 1.82 kg N/tree applied.

Abd El-Hamied (2007) using both compost tea, chicken manure extract and their combinations on leaf area (m²/vine) of Thompson seedless grapevines at Belkas, Dakahlia Governorate, Egypt, in 2003 and 2004 seasons. The grapevines were 15-year-old and grown in clay soil. Compost tea and chicken manure extract were tested at three concentrations (1:10, 1:20 and 1:30). They found that the highest values of leaf area were obtained from (the combination between compost tea and chicken manure extract at the concentration of 1:10 X1:10) the values were 14.87 and 13.97 m²/vine, in both studied seasons.

Therefore, the main target of this investigation is to study the effect of compost tea on vegetative growth, fruiting and yield, leaf mineral content and fruit quality of Washington navel orange trees.

MATERIALS AND METHODS

The experiment was conducted during 2006, 2007 and 2008 seasons to study the effect of compost tea on vegetative growth, fruiting and yield, leaf mineral content and nitrate and nitrite content of fruit juice of Washington navel orange trees, while 2006 season was considered a preliminary experiment. The experiment carried out at Agriculture Research Station of Mansoura Agriculture Faculty, Mansoura University, Dakahlia Governorate, Egypt.

The experiment conducted on 32-year-old Washington navel orange trees budded on sour orange rootstock (*citrus aurantium* L.) grown in clay loamy soil as shown in table (1), planted at 5x 5 m apart under furrow irrigation system and received the recommended management for citrus orchard.

Fifty-four trees were selected in healthy, nearly uniform in growth vigor and fruiting and arranged in a randomized complete block design, six treatments, three replicates and three trees for each replicate.

The used treatments were as follows:

T1- Control (treated with water only).

T2- Compost tea at 4 Liters /tree in mid-February (2L as soil and 2L as foliar application).

T3- T2 plus 4 Liters in mid-March (1/2 as soil and 1/2 as foliar application).

T4- T3 plus 4 Liters in mid April (1/2 as soil and 1/2 as foliar application).

T5- T4 plus 4.Liters in mid June (1/2 as soil and 1/2 as foliar application).

T6- T5 plus 4.Liters in mid August (1/2 as soil and 1/2 as foliar application).

Soil samples were taken to determine the properties of soil of experiment in three depths from soil surface, 0 to 30 cm, 30 to 60 cm and 60 to 90 cm. Such samples were completely mixed and subjected to mechanical and chemical analyse to determine certain properties of soil as included in table (1).

Table (1): Some mechanical and chemical analyses of the experimental soil

Mechanical analysis	(%)
Silt	44
Clay	42
Fine sand	13.18
Coarse sand	00.82
Texture grade	Clay loam
Cations	(meq/1:5)
Ca ⁺⁺	00.29
Mg ⁺⁺	00.69
K ⁺	00.016
Na ⁺	00.34
Anion	(meq/1:5)
CO ₃ ⁻	.00
HCO ₃ ⁻	.56
CL ⁻	.42
SO ₄ ⁻	.36
Macro elements	(ppm)
N	27.43
P	37.5
K	150
pH	7.88

Preparation of enriched compost tea

Compost tea was prepared from matured compost made from rice straw, farmyard manure, bentonite, rock phosphate, elemental sulphur and urea which had been composted in an aerobic heap for three months. To prepare the enriched compost tea, ten Kg of matured compost blended with one Kg molass, 500g (NH₄)₂SO₄, 50gMgSO₄.7H₂O and 10gmNaCl in a 150 litter plastic barrel, these ingredients were drenched in 100 litter tap water(previously stored to avoid the harmful effect of Cl₂ on microbial load of compost). This mixture had been allowed to stand in a shaded place for 7 days with a suitable daily stirring by an air compressor using a PVC pipe dipped in the barrel. After elapsing of incubation time, liquid mixture was filtered on a 100 mesh screen and became ready to use. The main traits of the produced compost tea are shown in table (2). Abdel-Wahab *et al.*(2007). Methodology as has been followed in this investigation is being determined as follows:

1- Vegetative growth measurements:

- 1-1- Shoot length (cm)
- 1-2- Leaf number / shoot
- 1-3- Leaf surface area (cm²) according to the equation of Chou (1966)

$$\text{Leaf area (cm}^2\text{)} = \frac{2}{3} \times \text{length (cm)} \times \text{width (cm)}.$$

2- Yield/tree (Kg/tree):

Yield was recorded at the harvesting time then calculated as Kg/tree by multiplication number of fruits to its weight.

3- Leaf Content of NPK :

3-1- Total nitrogen % was determined according to the method described by Pregle (1945); using micro-kjeldahl procedure.

3-2- Phosphorus % was estimated calorimetrically using the chlorostannus-reduce molybdo phosphoric blue colour method in sulphuric system as described by Jackson (1967).

3-3- Potassium % was photometrically determined in the digested plant material by using a flame photometer according to Black (1965).

4-Fruit quality

Nitrate and nitrite concentration were determined of fruit juice according to the methods of Singh (1988).

Table (2): Chemical and microbiological traits of the enriched compost tea

Trait	Value
pH	6.93
E.C.(ds m ⁻¹ at 25°C)	3.92
Total-N (%)	0.014
Total-p (%)	0.13
NH +4-N (ppm)	86.9
NO ⁻³ -N (ppm)	11.5
Total soluble N (ppm)	98.4
Available-p (ppm)	22.4
Extractable-Fe (ppm)	18.6
Extractable-Zn (ppm)	7.5
Extractable-Mn (ppm)	3.2
Extractable-Cu (ppm)	1.8
E4/E6(Extinction coefficient)	3.84
*Seed germination test (%)	91.0
Total count of bacteria (cfu/ml)	8.2x10 ⁷
Total count of fungi (cfu/ml)	7.4x10 ⁵
Total count of actinomycetes (cfu/ml)	1.2x10 ⁶

*Cress seeds incubated 48 hrs

Statistical analysis

All data of this investigation were statistically analyzed according to the technique of analysis of variance (ANOVA) for the randomized blocks designed according to Gomez and Gomez; 1984 using MSTAT-C" Computer software package. The treatment means were compared using the New Least Significant differences (N.L.S.D) according to the procedure outlined by Waller and Duncan (1969).

RESULTS AND DISCUSSION

1- Effect of compost tea application on vegetative growth characteristics of Washington navel orange trees

Data presented in table (3) showed effect of compost tea application on shoot length, leaf number/shoot and leaf surface area during 2007 and 2008 seasons, where all tested treatments generally gave significant increase in shoot length, leaf number/shoot and leaf surface area in both seasons of the study compared by control (without treatment), while T6 gave significant increase of shoot length (14.02-14.25 cm) in 2007 and 2008, respectively, comparing with the rest treatments except T5 and T4 in 2008. In the same line, T6 treatment gave significant increase on the leaf number/shoot (7.22) leaf/shoot in 2007 season comparing with the T2 and insignificant increase with the rest treatments of the study in the both seasons. Also T6 significantly increased the leaf surface area (18.74-17.54cm², respectively) comparing with the rest treatments except T5 (18.45) in the first season and T5, T4, and T3 (17.37-17.09-17.26 cm²) in the second season, respectively, consequently, the results cleared that the control treatment gave the lowest values of shoot length, leaf number/shoot and leaf surface area compared with other used treatments in 2007 and 2008 seasons. The beneficial effect application of compost tea on the vegetative growth characteristics can be attributed to the macro and micronutrients in compost tea substrate which including N, P, Fe, Zn, Mn and Cu beside high biological benefits of compost tea such as diseases control of fungi infection.

Table (3): Effect of compost tea application on shoot length, leaf number/shoot and leaf surface area of Washington navel orange trees during 2007 and 2008 seasons

Treatments	Shoot length (cm)		leaf number /shoot		leaf surface area (cm ²)	
	2007	2008	2007	2008	2007	2008
T1	8.85	11.39	4.82	6.84	16.77	15.28
T2	10.31	12.61	6.28	6.95	17.45	16.21
T3	11.87	13.02	6.45	7.00	17.54	17.26
T4	12.08	13.17	6.80	7.10	17.98	17.09
T5	12.04	14.22	6.73	7.25	18.45	17.37
T6	14.02	14.25	7.22	7.72	18.74	17.54
New. LSD	0.90	1.13	0.84	0.78	0.35	0.68

These results are confirmed with those of Moustafa (2002) on Washington navel orange trees who found that poultry manure increased shoot length and number leaves/shoot where poultry manure applied at (375g N/tree) in mid-December. Likewise, Abd El-Hamied (2007) with grapevines concluded that interaction between compost tea and chicken manure extract at (1:10 X 1:10 v/w) gave the best results on leaf surface area.

2- Effect of compost tea application on yield of Washington navel orange trees

Data tabulated in table (4) showed effect of compost tea application on fruits number and yield/tree of Washington navel orange trees

during 2007 and 2008 seasons. All tested treatments gave significant increase on fruits number and yield/tree values in both seasons of the study compared with control as well as T6 treatment gave significant increase on the fruits number /tree (397.81-225.25, in 2007 and 2008 seasons respectively) comparing with the rest treatments except T5 and T4 in the first season and T5 in the second season. Also, T6 treatment gave significant increase on the yield/tree (Kg) values (94.84-55.10, in 2007 and 2008 seasons, respectively) except T5 in the second season. Finally, the results cleared that the control treatment gave the lowest values of fruits number and yield/tree compared to other treatments in two seasons of the study (306.00-169.75 and 70.21-30.98 Kg in 2007 and 2008 seasons, respectively). Abstractly, compost tea proved to be the most efficient in enhancing tree fruiting of Washington navel orange trees hence it increased fruit set percentage, reduced June drop and improved tree yield (fruits number and yield Kg/tree).

Such findings could be explained on the basis of the beneficial effect of compost tea on vegetative growth due to it contains enough values of macro, micronutrients and has high useful amount of needed bacteria, fungi and actinomycetes. These results are in line with Moustafa (2002) on Washington navel orange trees when applied different sources of organic manure (cattle, rabbit and poultry manure) as surface and trench application. He found that poultry manure gave the highest values of number of fruits/tree and increased the yield/tree (Kg/tree). Likewise, Mostafa *et al* (2009) on Thompson seedless grapevines reported that the combination compost tea and chicken manure extract at concentration (1:10 X 1:10 w/v) gave significant increased the yield/vine.

Table (4): Effect of compost tea application on Fruits number /tree and Yield (Kg) /tree of Washington navel orange trees during 2007 and 2008 seasons

Treatments	Fruits number tree		Yield /tree (Kg)	
	2007	2008	2007	2008
T1	306.00	169.75	70.21	30.98
T2	349.25	191.33	84.37	43.93
T3	348.37	202.75	86.91	49.15
T4	387.00	213.75	87.61	49.84
T5	397.33	217.50	88.84	53.07
T6	397.81	225.25	94.84	55.10
New. LSD	10.02	9.24	3.75	2.89

3- Effect of compost tea application on the leaf mineral elements content of Washington navel orange trees

3-1- Nitrogen percentage in leaves

Data in table (5) show effect of compost tea application on leaf content of nitrogen during 2007 and 2008 seasons. All treatments of compost tea application gave significant increase in leaf content of nitrogen values in both seasons of the study compared with control, especially, T6 gave significant increase (2.99-3.08%, in 2007 and 2008 seasons respectively) comparing with the rest treatments of compost tea.

3-2- Phosphorus percentage in leaves

Data recorded in Table (5) emphasized that P% significantly increased by increasing the level of compost tea application in 2007 and 2008 seasons. All treatments of compost tea application gave significant increase in phosphorus content values in leaf in the two seasons of the study compared with control, where T6 gave significant increase on phosphorus content in leaf (0.276-0.288% in 2007&2008 seasons, respectively) comparing with the rest treatments. Also, control treatment gave the lowest phosphorus content values in leaf compared with other treatments in two seasons of the study (0.148-0.154%), respectively.

3-3- Potassium percentage in leaves

Table (5) cleared effect of compost tea application on leaf potassium content of Washington navel orange trees during 2007 and 2008 seasons, where the results showed that K% significantly increased by increasing the level of compost tea application in 2007 and 2008 seasons. All treatments gave significant increase Potassium content in both seasons of the study compared with control, whereas T6 treatment gave significant increase on Potassium content in leaf (1.98-2.02% in two seasons, respectively) comparing with the rest treatments. Also, the control treatment gave the lowest values of Potassium compared to other treatments in two seasons of the study (1.03-1.12% in 2007 and 2008 seasons, respectively), Generally, compost tea proved to be the most efficient in enhancing the leaf mineral content in leaves of Washington navel orange trees.

It can be attributed that application of compost tea are efficient in enhancing the N, P and K absorption by leaves and roots.

Generally the important role of organic manures due to available nutrient elements through reducing soil pH, increasing the exchangeable capacity for mineral nutrients and reducing loss of them by leaching through drainage process.

These results are in agreement with El-Cobbia (1999) with Washington Navel orange trees budded on sour orange rootstocks, who found that applying either biohumus or cattle manure markedly increased leaf N, P and K content, especially the high rates of them. Also, Ebrahiem and Mohamed (2000) on Balady mandarin trees found that supplying Balady mandarin trees with FYM or FM combined with mineral N source significantly improved the percentages of N, P, and K in the leaves compared with supplying the whole amount of nitrogen from the mineral source.,

Table (5): Effect of compost tea application on the leaf content of nitrogen, phosphorus and potassium of Washington navel orange trees during 2007 and 2008 seasons

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	2007	2008	2007	2008	2007	2008
T1	1.96	2.02	0.148	0.154	1.03	1.12
T2	2.28	2.26	0.186	0.192	1.28	1.34
T3	2.41	2.55	0.203	0.209	1.46	1.48
T4	2.53	2.74	0.225	0.232	1.62	1.65
T5	2.83	2.88	0.250	0.263	1.85	1.85
T6	2.99	3.08	0.276	0.288	1.98	2.02
New. LSD	0.15	0.06	0.007	0.006	0.07	0.05

4- Effect of compost tea application on fruit quality of Washington navel orange

Concerning to nitrate and nitrite concentration, data in table (6) showed that control treatment gave significant increase values of nitrate and nitrite content compared with other treatments in both seasons of the study (6.56-6.94 and 0.130-0.131 PPM in 2007 and 2008 seasons, respectively) except T2 in the second season increased nitrite content, while T6 gave the lowest values of nitrate and nitrite content compared with other treatments in two seasons of the study (4.42-4.64 and 0.087-0.091 ppm in 2007 and 2008 seasons, respectively).

These results are confirmed with those of Rabeh *et al.* (1993) on Balady mandarin trees, they found that organic manure (farmyard manure) application enhanced Vitamin C. Also, Mostafa *et al.* (2008) on seedless grapevines investigated the effect of different sources of organic fertilizers as partial substitute for N mineral fertilizers. They recommended that organic manures are of a great value in decreasing the concentration of both nitrate and nitrite in berries juice.

Table (6): Effect of compost tea application on nitrate ppm and nitrite ppm of Washington navel orange fruits during 2007 and 2008 seasons

Treatments	Nitrate (ppm)		Nitrite (ppm)	
	2007	2008	2007	2008
T1	6.56	6.94	0.130	0.131
T2	6.24	6.54	0.124	0.134
T3	5.84	6.12	0.120	0.124
T4	5.31	5.48	0.107	0.114
T5	4.73	5.03	0.093	0.092
T6	4.42	4.64	0.087	0.091
New. LSD	0.21	0.11	0.006	0.004

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تأثير شاي الكمبوست على أشجار البرتقال أبو سرّة

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أجريت هذه الدراسة خلال موسمى ٢٠٠٧/٢٠٠٨ لدراسة تأثير شاي الكمبوست على النمو الخضري والإثمار والمحصول ومحتوى الأوراق من العناصر والنترات والنيتريت بثمار أشجار البرتقال أبو سرّة واشنجطن.

أظهرت الدراسة أن جميع المعاملات المختبرة أعطت زيادة معنوية فى طول النموات الحديثة (١٤,٠٢ - ١٤,٢٥) وعدد الأوراق عليها (٧,٢٢-٧,٧٢) والمساحة السطحية للورقة (١٧,٥٤ - ١٨,٧٤) فى كلا موسمى الدراسة على الترتيب مقارنة مع المعاملات الأخرى، أيضاً أعطت المعاملة السادسة زيادة معنوية فى عدد الثمار/الشجرة (٢٢٥,٢٥-٣٩٧,٨١) والمحصول/الشجرة (٩٤,٨٤-١٠٠,٥٥ كج) فى موسمى الدراسة على التوالي بالمقارنة مع المعاملات الأخرى.

وكذلك أعطت المعاملة السادسة زيادة معنوية فى محتوى الأوراق من النتروجين والفسفور والبيوتاسيوم فى موسمى الدراسة (٣,٠٨-٢,٩٩، ٠,٢٧٦-٠,٢٨٨، ٠,٩٨-١,٠٢%) مقارنة مع المعاملات الأخرى.

وبالنسبة لمحتوى العصير من النترات والنيتريت، أعطت المعاملة السادسة أيضاً أقل محتوى منهما بالمقارنة مع باقى المعاملات الأخرى فى كلا موسمى الدراسة (٤,٤٢-٤,٦٤، ٠,٨٧-٠,٩١ جزء/المليون/١٠٠ملى عصير ثمار البرتقال أبو سرّة. وتعتبر تلك المعاملة مؤهلة للإستخدام لإنتاج ثماراً آمنة للإستعمال الأدمى وعلى درجة عالية من الجودة.