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Sugar Mill Compost as a Substitute of Peat Moss in Potting Media and its Effect on Sour Orange Rootstock Seedlings Growth

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INVESTIGATION on sugar mill compost as a local plant material for sour orange rootstock seedlings media was aimed to supplant the expensive imported peat moss. The study was conducted in the nursery of Horticulture Research Institute, Giza for two consecutive seasons. Uniform sour rootstock seedlings were grown in seven different potting media as follows; five various mixtures between sugar mill compost (SMC) and washed sand [(1:1), (2:1), (3:1), (4:1) and (1:2)] (v/v); while, the sixth medium was a potting mixture of peat moss & washed sand at (1:2) and the last one was washed sand alone. Data revealed that seedlings grown in potting medium of 4:1 (SMC) to sand gave the best results either in vegetative growth (leaves parameters, shoots weight & diameter and roots weight) or leaf chemical contents (chlorophyll a & b and leaf mineral elements) followed by 3:1 (SMC) to sand media, while, the sand medium produced the lowest seedlings growth incidences for both seasons. Generally, as the percentage of compost became greater; the seedlings showed better performance. The peat and sand mixture (1:2) outstrips the (SMC) and sand (1:2) in some parameters.

It could be concluded that sugar mill compost mixture with sand at the rate of 4:1 and 3:1 is economically and efficiently recommended as a potting media for citrus seedlings instead of peat moss medium.

Keywords: Citrus seedlings, Sugar mill compost medium, Sand medium, Peat moss medium, Seedling growth.

Interest in the use of compost, a long standard practice for organic production, is becoming more common either for row crop or for permanent crop growers. This interest is driven by a number of factors, including the recognition that conventional production practices often result in a loss of soil organic matter, which can lead to degradation of soil tilth and biological health. Another major factor is the large increase in compost supply, a result of the increasingly widespread practice of composting urban yard and landscape waste (Tim, 2000)

Composting is a biological process in which microorganisms convert organic matter into a stabilized humuslike substance. Many of the organic materials used for composting are inappropriate in their raw form for use on land or around living organisms because of the presence of odors, weed seeds, human

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pathogens, and storage and handling constraints. Composting helps to break down organic residues, stabilize nutrients, destroy weed seeds, and control possible on toxins or diseases (Hoitink & Keener, 1993 and Haug, 1993). The resulting compost has numerous horticultural and agronomic benefits and is environmentally safe for use on soils around plants, humans, and animals (Stratton *et al.*, 1995, and Barker, 1997).

Of all the different agricultural uses of compost products, use it as a growing medium component in ornamental crops production frequently receives high priority because of the relatively high value of nursery and greenhouse crops and the continual cultural requirement for organic matter for rooting substrates (Slivka *et al.*, 1992 and Tyler, 1993, 1996).

Egypt mild climate and accessible water sources drive into a year-round growing season providing a unique environment for developing a promising organic recycling compost production. Moreover, the expanding demanded on the citrus seedlings to cover the extended plantation for citrus trees in the new reclaimed areas and the replacement for old and undesired varieties in the Delta and the Valley requires much more of citrus seedlings production. One of the main basic facilities of seedling production is the potting media which reliant on the imported peat moss as the principal component of its mixture and also the most expensive one. Moreover, Fitzpatrick & Dennis (1991) and Meconnell, *et al.* (1993) stated that every time a container plant is sold, the rooting substrate is sold with it, necessitating the need for new potting mixtures to start new crop production cycles.

Therefore, this study aimed at examining sugar mill compost as a local substitute plant material for the imported peat moss so as hopefully reduce the seedling process expenses and an eco-compatible way for recycling such a valuable organic material.

Material and Methods

The study was conducted during (2005-2006) and (2006-2007) seasons at the nursery of Horticulture Research Institute, Giza on six–month-old uniform sour orange (*Citrus aurantium* L.) seedlings planted individually in black plastic bags (35 x 17 cm.). Seedlings bags were filled with seven different media mixtures as follows:

1- Sand alone.
2- 1:1 Sugar mill compost (SMC) to sand (v/v).
3- 2:1 (SMC) to sand (v/v).
4- 3:1 (SMC) to sand (v/v).
5- 4:1 (SMC) to sand (v/v).
6- 1:2 (SMC) to sand (v/v).
7- 1:2 peat to sand (v/v).

Sugar mill composting was processed after drying and grounding to particles ranged between 0.2 to 0.5 mm. Some supplemental materials were added – as a source of nitrogen and microorganisms promoting the decomposition of the organic matter - *i.e.*, 1 kg ammonium sulfate + ½ kg urea + 5 kg manure for 1 m^3 sugar mill. This mixture was moistened and mulched to retain it humid and warm. Then mixed up thoroughly twice a week for about 6-7 weeks. Table 1 presenting the analysis of the (SMC) made by "The Component of Integrated System for Recycling Agric. Residues" at the first season.

The treatments were arranged into complete randomized blocks with three replicates. Each plot contained ten bags. The seedlings were fertilized with balanced NPK liquid fertilizer once a week. The experiment was lasted for 18 months in both seasons. Leaf area was measured (for maturity leaf at the second week of September) by laser leaf area meter CI-203CA from CID. Inc. company. Morphological measurements *i.e.*, leaves number, shoots weight & diameter and roots weight were recorded. Leaf chlorophyll content was determined in fresh leaves (as mg/g of mature fresh leaf tissue) using DMSO (Dimethysiphoxied) according to Hiscox and Israelstam (1979). The growth percentage, which had taken according to an equation using the initial and final length of seedlings as follows (Hunt, 1979):

$$\text{Growth percentage} = \frac{A \quad B}{B} \times 100$$

Where: A = *Average finial seedling length at the end of the experiment.*

B = *Average initial seedling length at the bagging of the experiment.*

TABLE 1. Analysis of sugar mill composting

a: Physical properties

Analysis	Unit	
1 m^3 weight	Kg	412
Humidity	%	63.9
pH (1:10)	-	6.78
EC (1:10)	dS/m	1.73

b: Chemical properties*

Analysis	Unit	
Ammonium nitrogen	ppm	48
Nitrate nitrogen	%	Non
Total nitrogen	%	2.2
Organic matter	%	47.3
Organic carbon	%	27.4
Ashes	%	52.7
C:N ratio	-	12.5 : 1
Total phosphorus	%	0.38
Total Potassium	%	0.31

**As a percentage of the dry weight*

At the end of the experiment after the seedlings were taken out bags, divided into its three own organs (shoots, leaves and roots) where every one was separately washed with tap water and rinsed with distilled water. Therefore, they dried then dry weight of each organ was recorded. The dried leaf material (composed sample of mature leaves yielded at 8 months before collecting) used for determination of N, P, K, Ca, Mg, Fe, Zn, and Mn by using the procedures of Anderson *et al.*, (1968).

The data were statically analyzed according to Snedecor and Cochran (1972) at LSD of 5%.

Results and Discussion

Vegetative growth

The data of Tables (2&3), demonstrate that the various parameters of seedling growth vigor were positively, related to the organic matter content in the used medium. This was true for the two successive seasons of the study. In this line, seedlings grown in (4:1) (SMC) to sand potting medium recorded the highest values in respects of growth parameters *i.e.*, (plant height, leaves area, leaves number, leaf dry weight (%), shoots number, shoot diameter, shoot dry weight) followed by the other potting media according to the organic material proportion they contain. The sand medium produced the least vigor of sour orange seedlings under this study. Although the growth vigor of seedling grown in peat moss and sand (1:2) was better than those grown in sand, however, it was inferior comparing to the SMC media.

These results were in accordance with those obtained by (Fitzpatrick, 1986) who found that compost products resulted in plants that were significantly larger than plants grown in a control medium consisting of 40% peat, 50% pine bark and 10% sand. In addition, the growth percentage of seedling was significantly affected with the organic matter content in the potting media. Therefore, medium of (4:1) produced the superlative seedlings followed by (3:1) medium comparing to the other media. On the other hand, the sand medium recorded the lowest growth percentage. These results were in harmony with those obtained by Gouin, (1977) and Gouin & Walker, (1977) who found out that compost products have been successfully used in nurseries as soil amendments to increase productivity in various tree species. Moreover, Shiralipour *et al.* (1992) reviewed published studies on compost use in a wide variety of crops, including nursery crops, and reported that there were significant increases in crop productivity.

Root dry weight considered as an indicator for the root system growth as it is reflects the impact of different potting of media on seedlings development. It could be concluded from the tabulated data that the highest values were obtained from sour orange rootstock seedlings grown up in (4:1) and (3:1) (SMC) to sand media. While, (1:2) (SMC) to sand and peat to sand potting medium figures outdo the sand medium which recorded the least values in this respect. Aziz, (1998) clarified the positive effect of compost on root system as they stated that the soil microorganisms activity affected by compost application playing an important role in decomposition of soil organic matter, which leads to formation of humus and available plant nutrients promoting root activity. A similar response was also found on mixtures of sand, peat moss, sugar mill pulp, and clay (Salama *et al.*, 1994)

Regarding the shoot / root dry weight ratio, the obtained data clarify that the seedlings flowed the same previous trend where (4:1) then (3:1) medium achieved the best results if compared to the other media. Whereas, both of (1:2) (SMC) to sand and peat to sand gave nearly a similar results in this concern .

TABLE 2. Effect of potting media mixtures on Sour orange seedlings vegetative growth (2005-2006) season .

Treatment	Plant height (cm)	Growth percent-age	Leaf area (cm^2)	Leaves No.	Leaf dry weight (%)	Shoots No.	Shoot diameter (cm)	Shoot dry weight (g)	Root dry weight (g)	Shoot/ root dry weight ratio
Sand	41.39	55.52	24.84	37.00	39.50	1.80	0.66	10.85	10.79	1.006
SMC*:Sand (1:1)	47.72	65.95	29.00	52.00	48.92	3.40	0.71	13.44	13.15	1.022
SMC : Sand (2:1)	48.42	69.95	32.04	53.28	49.56	3.45	0.78	15.48	14.16	1.093
SMC : Sand (3:1)	49.07	75.68	33.71	56.83	52.45	3.80	0.81	16.37	14.17	1.155
SMC : Sand (4:1)	53.87	78.65	34.67	77.56	54.94	3.97	0.84	17.00	14.3	1.189
SMC : Sand(1:2)	42.02	61.05	27.58	47.39	42.86	2.20	0.69	13.16	12.93	1.018
Peat : Sand (1:2)	44.88	63.55	28.04	51.67	46.36	3.10	0.71	13.4	13.01	1.030
LSD 5%	5.87	3.26	1.48	4.27	9.08	0.57	0.06	1.65	1.24	0.06

TABLE 3. Effect of potting media mixtures on Sour orange seedlings growth vegetative (2006-2007) season .

Treatment	Plant height (cm)	Growth percent-age	Leaf area (cm^2)	Leaves No.	Leaf dry weight (%)	Shoots No.	Shoot diameter (cm)	Shoot dry weight (g)	Root dry weight (g)	Shoot/ root dry weight ratio
Sand	41.69	52.48	24.42	36.33	39.56	1.85	0.66	11.06	10.92	1.013
SMC*:Sand (1:1)	47.95	67.58	28.44	51.75	46.25	3.57	0.70	13.66	13.13	1.041
SMC : Sand (2:1)	48.83	69.66	31.43	50.17	48.21	3.63	0.82	16.11	14.13	1.140
SMC : Sand (3:1)	49.63	76.37	34.42	56.58	47.78	4.00	0.83	16.51	14.46	1.142
SMC : Sand (4:1)	54.95	79.97	33.16	73.17	55.29	4.34	0.84	17.52	15.02	1.166
SMC : Sand (1:2)	42.33	62.44	28.03	47.83	43.18	2.31	0.68	12.44	12.07	1.031
Peat : Sand (1:2)	45.16	64.16	28.48	50.67	46.26	3.29	0.71	12.61	12.14	1.039
LSD 5%	4.69	3.38	2.00	5.08	6.64	0.68	0.06	11.06	10.92	0.06

* *SMC: sugar mill compost*

Chemical properties

Chlorophyll (a)

From Tables (4&5) it could be noticed that leaves from seedlings grown either in (4:1) or (3:1) (SMC) to sand potting medium had the highest chlorophyll (a) values comparing to the other treatments. Again, the seedling grown in sand medium recorded the least values of chlorophyll (a) in their leaves. These results were in agreement with data obtained by Ebrahiem, *et al.* (2000) who clarified that FM (a by-product of the sugar industry) application provided better overall results compared with that of (FYM) farmyard manure for Balady mandarin trees grown on sandy soil.

Chlorophyll (b)

Relating to chlorophyll (b), we may concluded that the potting medium (4:1) (SMC) to sand attained the highest leaves content followed by (3:1) and (2:1) (SMC) to sand media in both seasons. Whilst, the sand medium figures was the lowest in this respect.

Leaf mineral content

The sugar mill compost as an organic matter in media mixtures act as a slow release source of nitrogen where it is contained 2.2% N (Table 1). Consequently, the greatest proportion of sugar mill compost in potting medium (4:1) (SMC) to sand brought about the highest rats in (N) levels in seedlings leaves under study. This was approved by Raviv (1998) who found that organic matter is a substrate for soil microorganisms, which enables, through their activity, enhanced nutrient cycling and weathering of soil minerals moreover composts contain considerable amounts of nutrients work as supplement plant nutrition

TABLE 4. Effect of potting media mixtures on sour orange seedlings leaves chemical contents 2005-2006 season.

Treatment	Chl.** a	Chl. b	N %	P %	K %	Ca %	Mg %	Fe ppm	Zn ppm	Mn ppm
Sand	3.12	1.06	1.97	0.12	0.59	3.37	0.57	51.99	47.31	23.90
SMC* : Sand 1:1	3.87	1.30	2.37	0.13	0.94	3.69	0.66	60.35	58.40	29.27
SMC : Sand 2:1	4.37	1.64	2.45	0.14	0.98	3.72	0.66	66.48	65.11	29.73
SMC : Sand 3:1	4.75	1.76	2.46	0.15	1.02	3.76	0.66	88.06	76.63	32.87
SMC : Sand 4:1	4.75	1.84	2.65	0.15	1.07	3.88	0.71	95.55	81.72	37.40
SMC : Sand1:2	3.26	1.06	2.21	0.13	0.82	3.50	0.62	56.25	52.60	23.99
Peat : Sand 1:2	3.42	1.30	2.31	0.13	0.86	3.54	0.65	59.99	57.31	28.99
LSD 5%	0.16	0.20	0.07	0.01	0.03	0.31	0.02	4.59	1.74	1.03

TABLE 5. Effect of potting media mixtures on sour orange seedlings leave chemical contents 2006-2007 season .

Treatment	Chl.** a	Chl. b	N %	P %	K %	Ca %	Mg %	Fe ppm	Zn ppm	Mn ppm
Sand	3.27	1.11	2.05	0.13	0.62	3.52	0.60	53.91	49.70	25.20
SMC*: Sand 1:1	4.09	1.37	2.48	0.14	0.99	3.89	0.69	63.83	61.51	30.93
SMC : Sand 2:1	4.62	1.73	2.59	0.15	1.04	3.94	0.70	70.10	68.71	31.36
SMC : Sand 3:1	5.01	1.87	2.60	0.15	1.07	3.97	0.70	92.96	80.58	34.79
SMC : Sand 4:1	5.02	1.95	2.80	0.16	1.12	4.11	0.74	101.19	86.10	39.50
SMC : Sand 1:2	3.44	1.12	2.31	0.13	0.86	3.70	0.66	59.49	55.48	25.10
Peat : Sand 1:2	3.61	1.37	2.44	0.14	0.91	3.73	0.69	63.05	60.46	30.61
LSD 5%	0.18	0.24	0.06	0.01	0.04	0.28	0.03	6.93	1.63	1.36

SMC*: Sugar mill compost Chl.** : Chlorophyll

The other media were ranked -in this concern- according to sugar mill compost percentage in their mixtures as follow; (3:1), (2:1) then (1:1) (SMC) to sand. In addition, the mixture of (1:2) peat to sand produced more (N) content in seedlings leaves than the comparable mixture with compost. These result was in line with those obtained by Porto, *et al* (2000) who indicated that the supply of organic matter improved the soil fertility, total N, and the stability of soil macro-aggregates.

While, there wasn't any significant effect for different potting mixtures on neither phosphorus nor calcium content in sour orange seedlings leaves under study.

Pertaining to potassium content in seedlings leaves, (4:1) medium proved to be the utmost one in producing seedlings enclosed the higher (K) level in their leaves. The other media came significantly in descending order as follows (3:1), (2:1) and (1:1) (SMC) to sand mixture then (1:2) peat to sand flowed by (1:2) (SMC) to sand medium and at last came the sand medium.

Moreover magnesium content in leaves had the same behavior in descending order but the differences between the treatments were not significant among them all.

Eventually, seedlings grown in (4:1) and (3:1) media showed more significant amount in iron and zinc leaf content with remarkable difference comparing to the other treatments. While, the least values were found in seedlings leaves produced from the sand medium. The obtained data were partially in accordance with those found by Salama *et al.* (1994).

Generally, it could be concluded from previous data that the organic matter percentage in the different mixtures of potting media was the lead factor in sour orange seedlings growth. Whereas. (4:1) and (3:1) (SMC) to sand media achieved the topmost results for the parameters examined in this study. Concerning the comparative relationship between the imported peat moss and the local sugar mill compost it could concluded that, the (1:2) peat to sand mixture exceed the similar percentage between sand and (SMC) in some measurements and equaled in others.

From economic viewpoint, the local sugar mill compost surpasses the imported peat moss in this concern. Whereas, 1 m^3 of (SMC) coasts about 30 pounds [(1 m^3 sugar mill = 10 pounds) + (1 kg ammonium sulfate + ½ kg urea + 5 kg manure = 5 pounds) + (processing coasts = 15 pounds)]

While, 1 m^3 of peat moss coasts about 300 pounds [peat moss package ($400L^2$) worth about 120 pounds *i.e.*, 1 m^3 peat moss = 300 pounds] which means that the peat moss coasts about more than ten times sugar mill compost coast.

Consequently, we may suggest that the potting media of (4:1) and (3:1) (SMC) to sand to be used for citrus potting media as an efficient low cost compost and a step forward for recycling such a promising local organic matter.

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كومبوست مصاصه القصب كبديل للبيت موس فى وسط الزراعه وتأثيرها على نمو شتلات أصل النارنج

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أجرى هذا البحث على كومبوست قصب السكر كمادة نباتيه محليه للاستخدام فى زراعه شتلات أصل النارنج بديلا عن البيت موس المستورد عالى التكلفة فى مشتل معهد بحوث البساتين لموسمى (٢٠٠٥ – ٢٠٠٦) (٢٠٠٦ – ٢٠٠٧). تمت زراعه شتلات متماثله لأصل النارنج فى سبع أوساط زراعه مختلفه خمسه منها لمخاليط مختلفه بين كومبوست قصب السكر والرمل المغسول (١:١) ، (١:٢) ، (١:٣) ، (١:٤) و (١:٢) حجما : حجم بالترتيب . بالاضافه الى مخلوط زراعه من البيت موس والرمل المغسول بنسبه (٢:١) حجما / حجم والبيئه الاخيرة كانت رملا مغسولاً منفرداً.

أظهرت النتائج أن الشتلات التى نمت فى مخلوط (٤:١) كومبوست قصب السكر الى الرمل أعطت أفضل النتائج بالنسبه للنمو الخضرى (قياسات الاوراق ، وزن وقطر الافرع ووزن الجذور) أو المحتوى الكيماوى للاوراق [كلوروفيل (أ ، ب) والعناصر المعدنيه بالأوراق] تبعها مخلوط (٣:١) كومبوست قصب السكر الى الرمل. بينما أعطت الشتلات النامية فى وسط الزراعة المكون من الرمل فقط أقل المؤشرات فى كلا الموسمين. بصفه عامه فانه كلما زادت نسبه الكومبوست كلما أظهرت الشتلات كفاءة أفضل.

بالنسبة لوسط الزراعة المكون من البيت موس والرمل بنسبه (٢:١) فانه تفوق على نفس نسبة المخلوط من الرمل وكومبوست قصب السكر فى بعض القياسات .

بناء على نتائج البحث ومن حيث الكفاءه والناحية الاقتصادية يمكن التوصية باستخدام مخلوط كومبوست قصب السكر والرمل بنسب ١:٤ ، ١:٣ كوسط لزراعه شتلات الموالح بدلاً من البيت موس.