

Evaluation of Some Organic Wastes as Growing Media for Promoting Growth of Date Palm (*Phoenix dactylifera* L.) Plantlets during Acclimatization Stage

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Abstract: The regular recycling of organic wastes in the soil is the most efficient method of maintaining optimum levels of soil organic matter. Recycling of organic matter in the soil should become a regular feature of modern agriculture. So, the main purpose is to evaluate the suitability of compost from different organic sources such as filter mud, spent mushroom and vermicompost mixed with sand (1:2 v/v) as growing media for promoting growth of one-year-old of date palm (*Phoenix dactylifera* L.) cv. Sakkoty plantlets produced from tissue culture during acclimatization stage, control treatment were received 1g/L NPK (19:19:19). Thereby, the experiment was carried out under the greenhouse condition at the Central Lab. of Date palm Res. & Develop. Hort. Res. Inst., Giza, Egypt during two successive seasons of 2016 and 2017 seasons. The results indicated that all treatments significantly increased plant height, number of leaves/ plantlet and trunk diameter. Moreover, the content of indoles, chlorophylls pigments, N, P and K in the leaves and total count of benefit microorganisms were enhanced with the superiority of mixture filter mud compost plus sand (1:2 v/v), which gave the utmost high means over all the other mixture in both seasons. A similar trend was also gained concerning the content of indoles and chlorophyll a, b and carotenoids in the leaves. However, the highest percent of N and K was recorded by the mixture treatment of spent mushroom plus sand (1:2 v/v) in the first season. So, it could be recommended to use filter mud compost as growing media and organic sources of nutrients to achieve consistent increase optimum levels of soil organic matter subsequent promoting growth, of date palm cv. Sakkoty plantlets produced from tissue culture during acclimatization stage.

Key words: Acclimatization • Date palm • Compost • Filter mud • Spent mushroom and Vermicompost

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) cv. Sakkoty is one of the oldest fruit trees in Egypt. It has played a vital role in human life for the last 7000 years [1].

Conventional organic growing medium used for adaptation date palm after tissue culture is peat moss. Quality peat is of high cost; particularly in countries have not such a natural resource. Moreover, peat is becoming difficult to obtain because the producing countries are legislating laws to conservation non-renewable natural resources and environmental protection [2, 3]. Egypt imports large quantities of peat moss, but supplies are limited and, as noted, the unsustainable use of peat raises

environmental concerns. The high costs of purchasing and shipping peat moss, result in greatly increase the cost of producing seedling under greenhouses conditions.

The economic and environmental costs of peat moss usage have encouraged the researchers to find less expensive peat substitutes, including agriculture wastes compost. Instead of being burned and cause environment pollution, agricultural waste and similar absorbent material could be used for the production of media for growing plants [4].

The filter mud (FM) is a common of sugar cane manufacturing wastes. In sugar industry, million tons of filter mud has been produced annually and the removal of such waste may lead to environmental pollution at least in

the factory area. Filter mud alone or with enrichment with certain nutrients increased the productivity of the crops and improved the physical and chemical properties of the media. Filter mud mixed with sandy gave highly significant augmentations in plant height, stem diameter, and number of lateral branches compared to peat moss [5].

Universal Mushroom production has increased by more than 6 folds in the last three decades, from about 1.2 million metric tons in 1980 to about 7.3 million metric tons in 2010 [6]. Spent mushroom wastes (SMW) are produced at the end of each production cycle, “spent” (used) mushroom substrates are left abandoned or discarded. One of the major environmental problems in the mushroom producing countries remains is the treatment and disposal of SMW [7]. Spent mushroom compost is made from the leftover after different flushes of mushrooms have been harvested because, it contains nutrients which could be used for the growth of plants also, SMW are nontoxic to plants and therefore, could be employed as soil amendment for different crops [8].

Vermicomposting is a product of non-thermophilic biodegradation of organic material by combined exploit of earth worms and associated microbes. It is a highly fertile, finely divided peat-like material with high porosity, aeration, water-holding capacity and low C:N ratios. The augmentation of plant growth by vermicompost may not only be nutritional, but also due to its content of biologically active plant growth-regulators such as auxins, gibberellins, cytokinins. Also, its highly contents of humic substances which have positive effect on plant growth, productivity and many physiological process [9-11].

Numerous studies have evaluated the use of composts made from waste materials soils growing media, especially as alternatives to peat moss for growing ornamental plants [12,13]. However, few studies have focused on the use of agriculture wastes for the production of horticultural and vegetables plants [14-16]. On the other hand no studies have evaluated the use of compost or agriculture wastes for the production of date palm for adaptation from tissue culture.

The main purpose of this study is evaluating the suitability of compost produced from filter mud, vermicomposting and spent mushroom wastes mixed with sand (1:2 v/v) as an organic growing media and as source of nutrients for promoting growth of date palm plantlets produced from tissue culture during acclimatization stage.

MATERIALS AND METHODS

A trial was conducted under the greenhouse conditions at the Central laboratory of Research and Development of Date Palm, Agricultural Research Center, Giza, Egypt during two successive seasons of 2016 and 2017 to evaluate different organic sources as growing media for date palm plantlets produced by tissue culture as alternative for traditional media (peat- moss).

Filter Mud Compost: There are problems with filter mud if used directly. It contains a number of pathogenic bacteria and moisture content is high. So, the best way to use it after the process, of an aerobic fermentation has been carried out the process of compost in the wooden boxes scale 1.5 x 1.5 x 2 meter. It was used two tons of clay residue filters after adjust the moisture content by air drying to reach optimum moisture and it turned weekly for four month until reach final product.

Vermicompost was kindly provided from Central laboratory of Organic Agriculture, Agricultural Research Center, Giza, Egypt. Spent mushroom compost was provided from greenhouse mushroom project, Ministry of Agriculture, Giza, Egypt.

Peat moss was provided by the Central laboratory of Research and Development of Date Palm – Agricultural Research Center, Giza, Egypt. Physio-chemical and biological properties of filter mud compost, vermicompost, spent mushroom and peat moss were shown in Table (1).

Data in Table (1) showed physical, chemical and biological properties of raw materials used as growing media spent mushroom had the lowest density (100 kg/m³) flowed by peat moss (175 Kg/m³) whereas, peat moss had the highest moisture content and organic matter. Also, peat moss had the lowest EC (0.3 dS/m) and all raw materials were free from pathogen microbes and nematode.

The experimental treatments were arranged in complete randomized design with three replicates as the follows:

- T1- Control - peat moss + sand (1:2 v/v).
- T2 - Spent mushroom compost + sand (1:2 v/v).
- T3- Vermicompost + sand (1:2 v/v).
- T4- Filter mud compost + sand (1:2 v/v).

Plant Material: Healthy and strong one year – old date palm plantlets (*Phoenix dactylifera*) cv. Sakkoty produced by tissue culture technique with an average of 60 cm height and 3-4 leaves/plantlet, were planted in 25

Table 1: Physical, chemical and biological properties of raw materials

Parameter	Unit	Spent Mushroom	Vermicompost	Filter Mud	Peat moss
Physical and chemical properties					
Density	Kg/m ³	100	700	535	175
Moisture content	%	7	74	34	80
pH (1:10)	----	7.66	7.63	7.44	4.3
EC (1:10)	dS/m	2.36	1.33	3.80	0.3
Total nitrogen	%	0.83	2.09	1.53	1.09
Ammonia nitrogen	(mg/kg)	700	56	84	70
Nitrate nitrogen	(mg/kg)	840	160	264	30
Organic matter	%	61.94	64.33	45.19	90
Organic Carbon	%	35.93	37.31	26.21	52.2
Ash	%	38.06	35.67	54.81	10
C/N Ratio	----	34 : 1	18 : 1	17 : 1	47.8:1
Total Phosphorus (P ₂ O ₅)	%	0.40	2.42	4.6	0.23
Total Potassium (K ₂ O)	%	0.8	0.76	0.41	1.7
Biological properties					
Nematode	Larve / 200g	Nd	Nd	Nd	Nd
Total Coliform bacteria	Cfu / g	Nd	Nd	Nd	Nd
Fecal Coliform bacteria	Cfu / g	Nd	Nd	Nd	Nd
Salmonella and shigella bacteria	Cfu / g	Nd	Nd	Nd	Nd
Total bacterial count	Cfu / g	2 x 10 ⁶	5 x 10 ⁶	8 x 10 ⁶	5x10 ²
Total fungi	Cfu / g	3 x 10 ³	6 x 10 ³	9 x 10 ³	10
Total Actinomycetes	Cfu / g	7 x 10 ³	4 x 10 ³	11 x 10 ³	2x10 ²

• Nd = not detected Cfu = Colony Forming Unit.

cm diameter plastic pots (plantlet/ pot) filled with different previous mixture of organic materials.. Plantlets were irrigated once every 6 days with 500 ml of fresh water/ plot. Control treatment received 1g/L mineral fertilizers (NPK, 19:19:19).

Recorded Data: At the end of each season the following data were recorded

Vegetative Growth: Plant height (cm), number of leaves /plant, and trunk diameter (cm).

Chemical Composition: Fresh leaf samples, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) according to Saric *et al.* [17] and total indole content were assessed as described by Larsen *et al.* [18]. Nitrogen uptake was determined using micro- kjeldahale method as described by Jackson [19], phosphorus colorimetrically as recommended by Hucker and Catroux [20] and potassium using flame photometer as explained by Cottenie *et al.* [21].

Biological Analysis: Total of counts bacteria, fungi and actinomycetes were counted according to Allen [22], Martin [23] and Williams and Davis1 [24] respectively. The plate count using the suitable serial dilutions and specific media was applied for estimation of the examined microbial groups. Total, fecal coliform and *Salmonella*

Shigella were counted according to Difco [25]. Nematode was examined according to Taylor and Sasser [26].

Statistical Analysis: Data were transformed before subsection to analysis of variance using COSTAT Computer Program and zero values were replaced by minimum values before transforming the data. Means were compared using LSD at 0.05 level of significant method and multiple range tests according to Sendecor and Cochran [27].

RESULTS AND DISCUSSION

Vegetative Growth: It is clear from data presented in Table (2) that plant height, number of leaves /plant and trunk dimeter were significantly increased in most cases of the two seasons as a result of use the mixture of sand and organic sources (2:1, as growing media) employed in this study with the superiority of mixture between filter mud with sand (2:1, v/v) which gave, in general utmost high means in all vegetative growth parameters, which gave the highest records of number of leaves/plant (8 and 9), plant height (98 and 125cm) and trunk dimeter (7.90 and 8.67) in the first and second seasons respectively. On the other hand, the control treatment recorded the lowest values of number of leaves/plantlet (4.67 and 4.66) pant high (83 and 89.33 cm), and trunk dimeter (6.90 and 6.40) in the first and second seasons respectively.

Table 2: Effect of various organic sources on vegetative growth of date palm plantlets (*Phoenix dactylifera L.*) cv. Sakkoty during acclimatization stage.

Treatment	Leaf number		Plant height (cm)		Trunk diameter (cm)	
	First	Second	First	Second	First	Second
T1- Control	4.67c	4.66c	83.0c	89.33d	6.90b	6.40d
T2- Spent Mushroom compost	6.33b	6.67 c	89.17b	114.33b	8.57a	7.90b
T3- Vermicompost	5.00c	5.33 c	90.50b	95.00c	7.13b	7.00c
T4- Filter mud compost	8.00a	9.00a	98.00a	125.00a	7.90a	8.67a

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 0.05% level.

Table 3: Effect of various organic sources on chlorophyll a, b and carotenoids (mg/g fresh weight) of date palm (*Phoenix dactylifera L.*) cv. Sakkoty plantlets during acclimatization stage

Treatment	Chlorophyll a		Chlorophyll b		Carotenoids	
	First	Second	First	Second	First	Second
T1- Control	0.37 d	0.36d	0.38 d	0.36 d	0.61 d	0.60 b
T2- Spent Mushroom compost	0.62 b	0.62 b	0.62 b	0.62 b	0.92 c	0.16 c
T3- Vermicompost	0.59 c	0.59 c	0.58 c	0.58c	1.0b	0.91a
T4- Filter mud compost	0.68 a	0.68 a	0.69 a	0.69 a	1.14a	0.92a

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 0.05% level.

Table 4: Effect of various organic sources on indoles contents (mg/100 gm fresh weight) of date palm (*Phoenix dactylifera L.*) cv. Sakkoty plantlets during acclimatization stage.

Treatment	Indoles (mg/100 mg/g f. fresh weight)	
	First	Second
T1- Control	0.29 c	0.28 c
T2- Spent Mushroom compost	0.26 d	0.25 d
T3- Vermicompost	0.36 b	0.36 b
T4- Filter mud compost	0.39 a	0.39 a

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 0.05% level.

The obtained results are in harmony with Azza [5] who reported that filter mud mixed with sandy gave highly significant augmentations in plant height stem diameter, and number of lateral branches compared to peat moss.

Chemical Composition

Chlorophyll Contents of Leaves: The results presented in Table (3) showed the effect of organic sources, filter mud, spent mushroom and vermicompost mixed with sand (1:2) on chlorophyll a, b and carotenoids. The data indicated that the highest value of chlorophyll a (0.68 and 0.68 mg/g fresh weight), chlorophyll b (0.69 and 0.69 mg/g fresh weight) and Carotenoids (1.14 and 0.92 mg/g fresh weight) in both seasons respectively were recorded in the leaves of plant treated with (sand + filter mud compost) (2:1 v/v).

Morover, vermicompost achieved the best values of carotenoids (0.91mg/g fresh weight) without non-significant with filter mud compost during the second season.

On the other hand, control treatment recorded the lowest values of chlorophyll a (0.37 and 0.36 mg/g fresh weight), chlorophyll b (0.38 and 0.36 mg/g fresh weight) and carotenoids (0.61 and 0.60 mg/g fresh weight) for both seasons respectively

Indoles Content: Indoles which are considered the important factor affect plant growth characters (shoots and roots). Data in Table (4) showed that the high significant values of indoles in the leaves 0.39 and 0.39 mg/100 gm fresh weight. resulted from treatment with filter mud compost + sand (1:2 v/v) in the first and second seasons, respectively. On the other hand, control treatment recorded the lowest value (0.29 and 0.28 mg/100 gm fresh weight) in the first and second seasons, respectively. vermicompost flowed the filter mud compost treatment where, it gave 0.364 and 0.360 mg/100g fresh weight in both seasons respectively.

Effect of Various Organic Sources on Nitrogen, Phosphorus and Potassium % Contents in the Leaves of Date Palm Plantlets

Nitrogen Content (%): Data in Table (5) indicated that, the highest percentages of N (227 and 343%) were recorded in the leaves of plants treated with filter mud, followed by vermicompost (150 and .0197%) and spent mushroom (130 and 173%) in the first and second seasons respectively.

Phosphorus Content (%): The significant and highest values of phosphorus percentage resulted by treating with filter mud compost (633 and 0.657%) in first and

Table 5: Effect of various organic sources on N, P and K (%) contents in the leaves of date palm (*Phoenix dactylifera L.*) cv. Sakkoty during acclimatization stage.

Treatment	Total Nitrogen %		Total Phosphorus %		Total potassium %	
	First	second	First	Second	First	Second
T1 – Control	0.137ab	0.037d	0.213bc	0.193d	0.135b	0.117b
T2- Spent Mushroom compost	0.130ab	0.173c	0.350 b	0.290c	0.173b	0.130b
T3- Vermicompost	0.150b	0.197b	0.160 c	0.610b	0.137b	0.153a
T4- Filter Mud compost	0.227a	0.343a	0.633 a	0.657a	0.303a	0.160a

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 0.05% level.

Table 6: Changes of total bacterial, fungi and actinomycetes counts of date palm (*Phoenix dactylifera L.*) cv. Sakkoty during acclimatization stage.

Treatment	Total count of bacteria ($\times 10^6$) cfu/g		Total count of fungib ($\times 10^3$) cfu/g		Total count of actinomycetes ($\times 10^3$) cfu/g	
	2016	2017	2016	2017	2016	2017
T1- Control	7.0b	12.0d	1.0c	4.0a	2.0c	13.0b
T2- Spent Mushroom compost	6.0bc	26.0c	2.0c	3.0ab	2.0c	2.0c
T3- Vermicompost	4.0c	33b	3.0b	3.0bc	4.0b	3.0c
T4- Filter mud compost	14.0a	39.0a	6.0a	2.0c	9.0a	19.0a

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 0.05% level.

second seasons respectively. whereas the control treatment gave the least values (0.213 and 0.193 %) in the first and second seasons, respectively as shown in Table (5).

Potassium Content (%): The significant highest Potassium percentage, resulted from plantlets treating with filter mud compost (0.303 and 0.160 %) in the first and second seasons, respectively.

Filter mud compost was successive as growing media during acclimatization stage of date palm produced from tissue culture through two seasons (2016 and 2017) since, the treatment increased the benefit microorganisms in rhizosphere zone for date palm. It's achieved the highest counts of total count bacteria (14 and 39×10^6 cfu/g) in the first and second seasons respectively with the filter mud compost treatment.

The same treatments (filter mud compost) during the first season gave the highest numbers of total benefit fungi in planet rhizosphere (6×10^3 cfu/g). On the other hand, control treatment successive on all other treatments in the second season where, recorded 4×10^3 cfu/g of total fungi. Meanwhile, growing media which contents filter mud compost gave the highest numbers of total actinomycetes in rhizosphere zone of date palm where, achieved 9 and 19×10^3 cfu/g either with 2016 or 2017 seasons respectively as shown in table (6).

The regular recycling of organic wastes in the soil is the most efficient method of maintaining optimum levels of soil organic matter and it should become a regular feature of modern agriculture. Moreover, growing medium

is an important factor for the production of crop in containers, and component properties of the potting media are very crucial for higher and quality yields of potted plants. Peat moss has been serving as an excellent substrate for potted plants, but it is a non renewable natural resource and its commercial utilization is of huge environmental concern. Moreover, continued use and diminishing reserves of commercial peat have led to price increases which demands consideration of alternative growing materials. Some types of these media are not produced in Egypt such as peat moss and it is imported from abroad which increase the production costs. These led the researchers to find alternatives media for peat moss. Many investigators reported the impact of different types of media and substrates on ornamental plants [12, 13]. In this study, we evaluated different organic sources filter mud compost, spent mushroom compost and vermicompost as growing media for promoting growth of date palm plantlets produced from tissue culture during acclimatization stage.

In Egypt, the sugarcane industry produced around 3.5% of filter mud cake (FMC) per weight of cane each year. This waste - when mixed with other soils- has been proved to be beneficial to crops and soils. Filter mud was superior to farmyard or poultry manure in sustaining crop yield and soil properties [28]. Results showed filter mud compost was the best growing media for date palm during acclimatization stage where, it was increased vegetative growth parameters, chlorophyll pigments, NPK uptake and enhancement benefit microorganisms in rhizosphere zone of date palm these result are in harmony with Chen

et al. [29] they reported that added filter mud to sand soil improved the vegetative growth and improve soil biological properties. Also, Cheesman [28] suggested that application of filter mud cake promote the conservation of soil moisture and leaching of most elements (including N) was greater from soil amended its filter mud cake than with other materials, Moreover, Azza [5] reported that Filter mud mixed with sandy gave highly significant augmentations in plant height stem diameter, and number of lateral branches compared to peat moss.

The seedlings shoot length, stem diameter, shoots dry and fresh weights, leaf area in the mushroom waste compost were significantly higher than peat moss. The mushroom waste compost showed a high porosity, ventilation, drainage and moisture storage capacity almost compatible to peat moss. The ability of this compost to provide nutrient elements was also reasonable. Analysis of variance of nutrient concentration showed a significant difference between the substrates.

increase in plant growth with vermicompost application has been reported in different studies vermicompost has been demonstrated to be a valuable soil amendment that offers slow, but a balanced nutritional release pattern to plants, providing nutrients such as available N, K, Ca, Mg and P that can be taken up readily by plants [30, 31]. Plant growth parameters like plant length and dry weight; root length and dry weight; number of leaves, area and dry weight were significantly higher in plots amended with different doses of vermicompost. Our results revealed that vermicompost was the second growing media for date palm produced from tissue culture during acclimatization stage where, it was competitive filter mud compost to release potassium (0.153%) also, increase carotenoid (0.919g/100g fresh weight) in the second season and help plantlets potassium uptake also, nitrogen and phosphorus were the second. As well as, increase date palm excrete indoles (364 and 360 mg/100g fresh weight) in both seasons. Author's recommendation use organic sources as growing media for promoting date palm, produce from tissue culture during acclimatization stage, have more impact excellent on vegetative growth, NPK content and enhancement biological activity in rhizosphere zone plant (specially filter mud compost) as well as, they are considering environment ecofriendly.

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