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Recycling of date palm by-products in Al Kuwaitet Research Station in Alain United Arab Emirates

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Summary

Introduction

Soils in Al Ain as in all dry areas are known as poor in organic matter. Organic matter has to be added every year to maintain the soil fertility and to guarantee sustainable agricultural productivity. The needs of organic fertilizer become more important with intensification and increase of productivity. The price of organic ferilizer is rising annually.

Given the lack of manure, the compost can be used in support or replacement as organic fertilizer. Recycling and reuse of date palm by-products in research station in UAE can ameliorate the soil quality and to reduce the cost of manure supply. Composted date palm and fruit trees by-products can enhance soil fertility and can also avoid negative effects on the pollution and disease dissemination and insects living in vegetal waste. The common practice elimination of by-products by burning is disputed the health risks and even more for the negative effects on the environment.

The main problem of date palm by-products is their dryness and cellulose-rich consistency that requires prior grinding before their composting. The process of composting need also supply of water and this can create managing and pollution risk problem.

This study is presented as a technical concept note of establishment of composting date palm and fruit trees station in the Al Kuwaitet research station in Al Ain. Just date palm and fruit trees by-products are considered but sure that the volume of agricultural wastes is more important with other production activities.

This study aims to introduce the experience of better utilization of the date palm and citrus fruit trees by-products for soil fertilization and to reduce the bad effect of burning or the stocking by-products in the station.
However, the unvalued by-products may constitute an encumbrance and can contribute to the development of harmful diseases for the date palm and other plants.

2- Principals of vegetal by-products valorization by composting

2.1- Definition of organic matter:

Mustin (1987) designate the biomass as "The total biomass of the organisms living on earth (plant and animal wastes) and which chemical energy comes from a very small amount of solar energy absorption''. Biomass is then defined as the energy source, available at all in nature.

2.2- Compositing process:

Composting is a method of natural degradation of organic matters. Composting allows obtaining an organic amendment, what is named Compost. Mustin (1987) defines composting as "the biological process ensuring the decomposition of the organic components of the by-products and waste into organic product''.

Composting involves various microorganisms in an aerobic process. This process takes place in the presence of oxygen, essential to respiration of decomposers-organisms: bacteria, *fungi*, *algae*, *protozoae*, small invertebrates etc. These are primarily bacteria that operate best decomposition of fermentable organic matter by aerobic means and at neutral pH. During the process, a part of the organic matter is breathed by microorganisms that release of the carbon dioxide and water. Nitrogenous substances are recomposed into various molecules including precursors of humus acids. The first phases of composting concern simple hydrocarbon molecules, in very exothermic processes of respiration. All will be an important warm-up for bacteria that will survive are thermophile and some high mesophylls.

Complex molecules are degraded in a second time by other low mesophyll bacteria, or even by psychrophilic bacteria. The entire process is done in 2-3 months to get compost at the beginning of stabilization (Mustin, 1987).

2.3- Composting methods:

2.3.1- Composting in trench:

This is the simplest mode consisting of infield deposits of organic waste either households or vegetation. It often incorporates manure to begin the process of degradation of organic matters and is watering to maintain a humidity of organic matter in transformation. The trench is usually covered with sand to keep the Interior moisture and avoid odors. The problem with this type of composting is no possibility of returning and airing composted wastes. Its advantage is to be able to mix lots of green wastes and even dry by-products if they are not woody.

2.3.2- Composting in stack:

In stack composting is a long process. Composting of the waste lasts from 6 months to a year. It is common to mix shredded plants to manure (2/3, 1/3 or 3/4, 1/4) to balance the compost and help its decomposition. This is the system used in the open composting stations. The stack can be variable-length adapted to the available area. The advantage of this mode is that you can easily stir the compost to aerate it and easily control the temperature of the compost.

2.3.3 - Composter composting:

Composter is a widely used mode in Europe. The composter is a cylinder placed in a bathing area. This system accelerates the composting process and avoids the nuisance caused to animals. Its boundaries are the need for mixing of waste, however it can see a less easy mixing and volume constraint.

2.4- The basic rules of composting:

The first composting rule is to mix different organic wastes. As known that decomposition of organic waste can be done in the presence of water, the 2nd rule of composting is to maintain the organic product to compost sufficiently moist. The 3rd and last rule is to return and regularly aerate compost (ideally every 15 days) in order to work properly, micro-organisms which require oxygen and therefore air. It's also possible to help ventilation by integrating fibrous elements (cut branches of approximately 5 cm in length).

2.5- Characteristics of the compost:

2.5.1- Definition of the compost:

Compost is the product resulting from the processing of mainly organic waste and which is rich in stable organic matter (humus). Compost is a soil enriched with fulvic and humic acids (Mustin, 1987).

2.5.2- Organic composition of compost:

The C/N ratio or carbon report on nitrogen is an indicator that allows judging the degree of evolution of organic matter, i.e. its ability to break down more or less quickly in the soil.

The microorganisms in the soil (micro fauna) have an average C/N ratio of 8. They consume two-thirds of carbon for energy (converted to carbon dioxide) and a third for their constitution. Nitrogen is to him almost only used for the constitution.

The nutritional balance of microorganisms is therefore located at C/N ratio of 24. Below this report, nitrogen is in excess and therefore will be released, the availability of plants. Above, the nitrogen will be collected in the soil solution to meet the needs of microorganisms.

It is commonly accepted that the ratio C/N of a product is high, more it slowly decomposes in the soil but most got humus is stable. This indicator is frequently used in practice to clarify the use of an unknown organic product. To make composting under optimal conditions, the C/N ratio should be between 15 and 30. Indeed, if the mixture to compost is too low in nitrogen, it will not (no degradation) heat. If the proportion of nitrogen is too high, the compost can overheat and kill microorganisms in the compost. The C/N ratio is very high for the material plant cool (50 to 150 for straw) and decreases throughout its decomposition by stabilizing around 10 per humus.

The effect of the incorporation of residues on the dynamics of nitrogen in the soil can be described by three parameters: the assimilation efficiency (proportion of carbon decomposed by microorganisms which is assimilated), the ratio of residues and microbial biomass C/N ratio. Used alone, this criterion of quality has its limits: two products with the same C/N can have different actions on the evolution of the content of soil microorganisms. The C: N ratio must therefore be regarded as an indicator of quality to be supplemented by other information (Mustin, 1987).

2.5.3- Mineral composition of compost:

2.5.3.1- Nitrogen:

A portion of the organic nitrogen (proteins, nucleic acids, urea) turns into mineral nitrogen (NO_{3-}, NH_4 +, NH_3) under the action of bacteria and other specific microorganisms that possess an effective biochemical degradation processes.

The other part of the organic nitrogen forms complexes with derivatives of lignin or humus. These complexes are stable structures that slow down the degradation of organic nitrogen. There is conservation of a portion of the nitrogen in organic form that limits losses by nitrogen leaching during storage and spreading. There is very little loss of nitrogen, and when this is the case it is especially form gaseous (NH_2 and NH_{4+}). Thus, when compost is brought down, nitrogen is, the first year especially in organic form while it mineralizes more subsequent years. The fertilizing value of nitrogen is therefore generally low but should not be overlooked in the event of significant contribution.

2.5.3.2- Phosphorus:

After degradation of single elements, phosphoric acid is released. Its rate then decreases but very little. However, composts have a generally rather interesting content of phosphorus.

2.5.3.3- Potassium:

Potassium is a highly soluble in water. Unless it is highly leached, it diminishes very little also. Thus, found in sizeable concentration in compost manure.

2.6- Control of compost:

Compost is all the more interesting to use it is well stabilized. Indeed, the presence of materials yet which may be fermented opposes the germination of the seeds.

Composts produced on areas of urban waste composting are often sold. Therefore these products require monitoring of their quality on the one hand and their composition on the other hand.

The fact that these composts can contain toxic materials, heavy metals and various other contaminants (pesticides, etc.) prompted legislation involving their analysis. The French Standards (NF U 44-051, NF U 44-095) require the composts to meet certain standards before being put on the market.

3- Qualities of date palm by-product compost:

3.1- Needs of manure to help the composting process:

Date palm by-products are woody and mixing with manure are necessary to start the process of decomposition.

Tests are conducted in many countries for the improvement of the quality of the compost produced by adding various manure and controlling the temperature. The results of incorporation of sheep or rabbits manure are analyzed in table 1. It shows a report C/N ratio is relatively low, and must work to reach a rate of 15 recommended for a good breakdown of the organic matter (Mustin, 1987). The low report may be according to Mustin (1987) for compost overheat and may cause the death of microorganisms.

Tab. 1 : Physicochemical characteristics of the compost produced in station with adding different manure origin

Physico-chemical parameters	Relative levels of compost C1 (rabbit)	Relative levels of compost C2 (sheep)
Dry Matter (%)	39	41.7
Organic Carbon	26.13	18.48
Organic Matter	45.29	31.98
C /N	**13**	**11**
N (%)	2.01	1.68
K^{+}(%)	0.83	0.61
Ca^{+2} (%)	8.39	10.11
Mg^{+2} (%)	1.4	0.93
P (%)	3.13	0.86
Na (%)	0.55	0.32

Source : Bouhaouach et al., 2009

3.2- Physico-chemical characteristics of date palm by-products compost:

Sghairoun and Ferchichi (2013) have demonstrated that composted date palm leaves have following physicochemical characteristics:

-a pH near neutral (7.5),

- a moisture rate at maturity close to 41.52%,

- a rate of organic matter (OM) of 44% of the dry matter,

- a density of 0.39 g/cm3,

- a C/N ratio of 14.9,

- High conductivity (2.48 mS / cm).

The quality of the compost produced of dry date palm by-products does not vary from other sources of plant materials. These results have been presented by Sghairoun and Ferchichi (2013) referring to the work of Mustin (1987) on the compost.

Tab. 2 : Physicochemical properties of date palm leaf compost

Parameter	pH	H (%)	N (%)	C (%)	C/N	HNO3 - (%)	NH4 (%)	CE (ms/cm)	MOT (%)	S (g/l)	D (g/cm^3)
Average	7.55	41.52	0.7	10.43	14.9	0.025	0.098	2.48	44	1.58	0.39

H: Humidity, N: Azote, C: Carbon, CE: electric conductivity, MOT: Total Organic Matter, S: salinity, D: Density.

Source : Sghairoun and Ferchichi (2013)

Tab. 3 : Minerals contents of date palm leaf compost

Parameter	K	Ca	Mg	Fe	Cu	Sn
Average (mg/kg)	145	189	13	1.6	0.27	0.8

K: Potassium, Ca: Calcium, Mg Magnesium, Fe: Iron, Cu: Copper, Sn: Selenium

Source : Sghairoun and Ferchichi (2013)

The composition of date palm leaf compost of micro elements: Sn (*Stannum*), Ac (*Actinium*), Hg (*Mercury*), Cd (*Cadmium*) and Sb (*Stibium*) as reported by (Sghairoun and Ferchichi, 2013) is below the DL (Limit detection) of the WHO (World Health Organization).

3.3- Microbiological qualities of the compost produced from date palm by-products:

The microbiological quality of the compost produced from dried date palm by-products is in accordance with the international sanitary standards set by AFNOR (French Association of standardization) (2004) regarding the quality of compost.

Experiments conducted in Tunisia chows the results presented down (table 4) in accordance with the AFNOR standards.

Tab. 4 : Microbiologic evaluation of date palm compost

Germ searched	Limit value of NPP	Results
Total Coliforms	>110 104 germ/g	2.1 **103**
Faecal Coliforms	>110 104 germ/g	2.2 103
Streptococci	>110 104 germ/g	1.5 103
Escherichia coli	>110 104 germ/g	2.4 103
Salmonella	Absence in 1g	0

NPP:

Source : Sghairoun and Ferchichi (2013)

4-Evaluation of the Kuwaitet station by-products volume:

4.1- Procedure for evaluation of date palm by-products volume:

The by-products of date palm trees are mostly composed of leaves, bunches and *Fibrillium* (lif). Discarded dates and seeds are not counted due to their destination for processing or as animal feed.

Waste assessment was conducted in several countries and by several authors. The most realist results are presented here.

Evaluation was conducted in Tunisian coastal oases (Ben Salah, 2012) was 21 kg per date palm tree.

Moussaly (2014) presents an assessment of oases by-products of 33.5 kg per date palm tree.

Evaluation conducted in Libyan oases of Farag Kassem and Lairje (2010) showed a total of 25 kg per palm tree.

In this study the base of **25 kg** by date palm tree will be the reference as it's about the average of the three evaluations.

4.1- Evaluation of date palm by-products volume:

The total number of date palm trees in Al Kuwaited is 2,351 trees, producing a total of 25 kilograms of by-products per year. The total is about 59 Tons per year.

Tab. 6 : Volume of date palm by-products evaluation in Al Kuwaitet research station in Al Ain

Research Station Al Kuwaitet	Number of date palm trees	Volume of by-products (based on 25 kg per date palm per year)
	2,351	58,775

4.3- Estimating of fruit trees by-products volume:

Just citrus trees are considered as fruit trees in Al Kuwaited research station. For other fruit trees no data was available. For the citrus trees an estimation of 10 kg per tree per year of by-products of pruning and leaves seems very realistic. For 1,700 fruit trees in the Kuwaitet station the total by-products per year is estimate at 17 tons per year.

Tab. 6 : Volume of fruit trees by-products evaluation in Al Kuwaitet research station in Al Ain

Research station Al Kuwaitet	Number of fruit trees	Volume of by-products (based on estimation of 10 kg per tree per year)
	1700	17,000

4.4- Estimating of other green waste in the station:

Green waste other than cultivated plants, in absence of any recorded data assessment is based on estimations. Green waste of weeds and other cultivated can be estimated to one ton per hectare per year.

The total of green waste is estimated of a total (50.9 Ha * 1 tons per hectare per year which is 51 tons per year).

4.5- Total estimated waste volume:

The total available by-products are about 127 tons. The date palm by-products are about 59 tons, the citrus trees produce about 17 tons and there are about 51 tons of green wastes per year.

Tab. 7 : Total volume of by-products evaluation in Al Kuwaitet research station in Al Ain

	Number of trees	**Calculation in Kg**	**Estimation in Tons**
Date palm	2,351	58,755	59
Citrus trees	1,700	17,000	17
Green wastes		50,900	51
Total			**127**

4.6- Evaluation of organic fertilizer needs of oases:

Organic fertilizer needs is evaluated as the ‘minimum quantity' need for organic fertilizer.

For date palm, the guide of fertilization prepared by ADFCA for date palm fertilization present needs of 10-15 kg per tree per year of age. We estimate at 100 kg per tree per year. For Citrus trees an estimation of 50 kg per year is considered.

Tab. 8 : Volume of organic fertilizer needs in Al Kuwaitet research stations in Al Ain

	Number	Needs in Tons
Date palm	2,351	235
Citrus trees	1,700	85
Total		320

5-Technical conception of the composting station:

5.1-Composition of composting station:

The composting station proposed to create in the research station is small scale with capacity of composting 4 tons per week. The composting station must include 5 units of components starting from the area of collecting and drying by-products to the final unit of stocking or packing the compost ready to use in fertilization.

5.1.1- Area of stocking by-products:

The area of receiving unit (Leaves and bunches) with large capacity (total area have to be almost 5000 m^2). If the leaves still wet when are collected, it is possible to keep they drying in the area of collecting. This will make easy their grinding later.

Collecting and stocking raw material

5.1.2- Area of grinding:

Grinding area must be in construction room or at minimum covered area. The grinding machine capacity has to be a minimum of 100 kg of waste per hour. Normally such grinding machines are available in national market.

Grinding date palm dry by-products

5.1.3- Area of soaking grinded by-products:

These area components are a series of trenches for soaking of waste. In this area it need water supply and drainage.

This unit is generally the most contested part of the station. Water for soaking compost has to be recycles before the discharge into the drainage network.

Soaking grinded by-products in water

5.1.4- Area of composting the socked material:

After soaking, by-products are mixed with manure at a rate of 2/3 of homogenate grinded date palm by-products with 1/3 of manure. The returning of the stacks can be made by a turning propeller trailer operated by a power outlet to the tractor. It is also possible to make this operation manually each 2 weeks.

Composting in stacks

5.1.5 - Area of storing complete prepared compost:

The store area has to be minimum capacity of 200 tons. Compost can be packed and stored or in plastic bags of 10, 20, 50 kg or in bulk in heaps under a shade.

When packed the compost can be used in the station or transported to other stations of also commercialized in market.

Packing compost

5.2-Technical station characteristics:

This composting unit is a small scale and adapted to the production of vegetal waste of the research station.

The capacity of the year is about 208 Tons and can be planned of a weekly capacity of 4 tons. It is possible also to plan six working months by multiplying the capacity by 2, to 8 tons per week.

It is also possible to integrate the by-products of the two other stations: Salamat and Bani Yes. The total date palm by-products per year for the both stations are (886 trees * 25= 22.15 tons).

Tab. 9 : Technical characteristics of the planned composting station

Total by-products of date palm, fruit trees and green wastes	127 tons
Quantity of fertilizer to add to raw compost (2 by 1)	64 tons
Total Volume of waste	181 tons
Technical capacity of the station (tons of by-products per week)	**4 tons**

Conclusion:

Date palm by-products constitute the largest volume of research station agricultural waste. The implementation of composting date palm by-products can join tow benefits: reduce the environmental effect agricultural waste and improve the soil fertility.

Attempt of evaluation of oases by-products the Kuwaitet research station covering a total area of 50.9 hectares and containing a total of 2,351 date palm trees of 46 cultivars and 1,700 citrus trees. The estimated volume of the date palm weed annual by-products is about over 58,775 kg produced per year. Organic fertilizer needs only for the date palm are estimated at 235 tons per year. Management by date palm plant waste composting could participate to cover partially the station organic fertilizer needs.

The main risk of installing date palm weed by-products composting station in Al Kuwaitet is the habitations proximity, what is can be considered is disturbing factor. Odors and insects can be the problem of the station because of the using water to facilitate composting by-products.
This condition may cause presence of mosquitos and insects and can cause problem especially in habitat area.
It's necessary to follow environment regulations before installing the composting station. Risks cover sills and insects.

The capacity of the composting station is 200 tons per year. It is possible to enlarge the capacity to cover by-products of the others smaller research stations of Salamat and Bani Yes. Just the date palm in both stations produce about 22 tons per year. If other fruit trees are considered may be the capacity will reach 50 Tons per year. This concept note has to be followed by an economical study to evaluate the cost after studying the available needed machines and the offered area to compost station and the capacity of water supply.

Bibliography

- ✓ **AFNOR** (Association Française de Normalisation) **2004.** French regulation of the organic waste's agronomic valorization. Microbiological Test. Paris: French Association of standardization.
- ✓ **-Atkinson G.**, **Dubourg, W. R., Hamilton, K., Munasinghe, M., Pearce D. W. and C.E.F. Young 1997**. *Measuring Sustainable Development:* Macroeconomics and the Environment. Conference Justice and Poverty: Examining Sen's Capability Approach, 5-7 June 2001, Cambridge University.
- ✓ **-Ben Salah M. 2012.** Rapport d'expertise technique sur la biodiversité oasienne en Tunisie. RADDO & ASOC Gabès.
- ✓ **-Bouhaouach H., M. Culo et K. Kouki 2009.** Compostage et valorisation des déchets oasiens pour l'amélioration du sol et de la productivité. Actes du Symposium international « Agriculture durable en région méditerranéenne » AGDUMED. Rabat. Maroc 14-16 Mai 2009. Partie 4- Cultures, itinéraires techniques et productivité : 235-240.
- ✓ **-Farag Kassem A.M. and Lairje A.B. 2010**. An economic study of palm dates trees residues and methods of using it in the Arab World. Faculty of Economics - Derna - Omar Al- Mukhtar University.
- ✓ **-Kouki K. et H. Bouhaouach 2009.** Etude de l'oasis traditionnelle Chenini Gabès dans le Sud Est de la Tunisie TROPICULTURA, 2009 (27-2) : 93-97
- ✓ **-Mustin M. 1987.** Le compost. Gestion de la matière organique. Ed. Francois Dubusc. France. 954 pages.
- ✓ **-NF.** Normes Françaises NF U 44-051 "amendements organiques" et norme NF U 44-095 " amendements organiques obtenus par compostage et contenant des matières issues du traitement des eaux, d'intérêt agronomique". www.valid-compost.com/valorisation/cadre-reglementaire/. Consultation : Aout 2011.
- ✓ **-Sghairoun M., M.S. Belkhadi et A. Ferchichi. 2006.** L'estimation quantitative des sous-produits de palmiers dattiers. *Revue des Régions Arides -Numéro spécial.* Actes du séminaire international : Aridoculture et cultures oasiennes : voies pour un développement durable en zones arides. pp : 422-424.
- ✓ **-Westerman P.W. and J.R. Bicudo. 2005**. Management considerations for organic waste use in agriculture. Bioresource Technology » 96 (2005) : 215-221.