The Possibility of Using Garbage Compost in Growing Vegetables in Tartous City. Case Study: Tomato

Shafak Harfoush[*(1)]

(1). Directorate of Solid Waste Management, Tartous, Syria.
(*Corresponding author: Dr. Shafak Harfoush. E-Mail: SHAFAKHAR@hotmail.com).

Received: 25/10/2020 Accepted: 01/01/2021

Abstract

The purpose of the research is to identify the properties of the compost produced by the garbage and to rationalize its use in the cultivation of vegetables. Tomato was studied as a case study. This research was conducted at Matan El-Sahel village in Tartous governorate during the period started from 2/3/2019 to 2/6/2019. The samples were taken from the compost then to the laboratory for tests to detect the physical and chemical properties of the compost. Tomato seedlings were sown on three medium of compost viz. 100% compost, 75% compost and 0% compost, and plant characteristics were determined to study the effect of compost on plant growth and compost properties. The results showed the ability of the compost to improve the physical and chemical properties of the soil and the ratio of the heavy elements were within the permissible limits (Cd, Pb, Ni and Cr). The study recommended using the compost to get safe germination of vegetable seeds after mixing it with the soil (75% compost + 25% soil).

Keywords: Garbage compost, Organic matter, Heavy elements, Tomato.

Introduction:

After the significant development in the waste recycling industry, solid waste has been shown to be a significant reserve for the agricultural mediums despite its health problems and contaminants (Chahin, 1996). Municipal Solid Waste (MSW) produced in developing countries is estimated at 0.35-1 kg/person/day (Chahin, 1996), and the most important feature is the containment of a large proportion of organic waste, which may reach 90% of the total size of the total, in addition to a small proportion of non-recyclable materials such as glass and metal (Chahin, 1996). This is primarily due to the preparation of food from fresh vegetables and not from canned food (Chahin and Awad, 2001; Chanyasak *et al.*, 1982). The high organic content of waste is an important advantage because it is the basic raw material of the composting process (the production of fermented humus), which is rich in humic substances under the influence of living organisms (Gabreala, 2010). These products are known as compost. These specifications allow the use of compost in the agricultural field as organic fertilizer mixed in the soil or as a mulch surface layer or as an agricultural substrate for cultivation in nurseries (Chanyasak *et al.*, 1982).

Therefore, many researchers recommended the fermentation of organic materials from the remnants of cities, remnants of organic industry and the remnants of field farming, forests and green areas as a way of economic disposal and as a way to mitigate the negative impact on the environment (Omer, Dede *et al.*, 2006; Garcia-Gomez *et al.*, 2002).

The agricultural mediums are very important for the success of the propagation process; therefore it is necessary to search for the best available medium or to create new mediums by mixing and processing them to create agricultural mediums that achieve the highest percentage of safety, germination and growth in nurseries (Elena *et al*., 2017).

The purpose of the research is to identify the properties of the compost produced by the garbage and to rationalize its use in the cultivation of vegetables.

Materials and Methods:

Laboratory experiments were carried out on compost and its mixtures to determine some of its physical and chemical properties. A field experiment was then carried out by cultivating the tomato plants on the compost and its mixtures at the greenhouses. Tomatoes were selected because more than 75% of the farmers in Tartous use compost to fertilize tomato seedlings.

Compost preparation:

The study was divided into two parts: field experiment and laboratory work. The compost samples were taken from different parts of the compost pile resulting from the fermentation of organic waste. They were placed in large bags and transported to the greenhouses for processing for agriculture. A sufficient amount of the same compost was placed in small polyethylene bags and then closed and transferred to Tishreen University, Latakia governotate/Syria, for laboratory analysis.

Compost Physical properties:

To determine the physical characteristics of the studied medium, sensory characteristics were recorded such as color, odor, texture and content of exotic elements. The humidity of the agricultural medium was also determined according to Ala-Aldin, (1989):

Moisture% =[Wet Weight (g) - Dry Weight (g)] / Dry Weight (g)]

Compost chemical properties:

PH, salinity, organic matter content, organic carbon ratio, nitrogen content and nutrient content were measured.

- Acidity number (pH):

pH value was estimated using pH-meter using 5: 1 (weight: volume) extract.

-Salinity electrical conductivity EC (m mhos):

The salinity of the agricultural medium was determined by measuring the electrical conductivity using the measuring electrode of the conveyor device using 5: 1 (weight: size) (Hesse, 1971).

-Organic matter (OM) and organic carbon (OC):

(OM) was measured as a percentage in the incineration method for 4 hours at a temperature of (550 °C), where the weight loss is organic matter (Jackson, 1958).

While (OC) was calculated by dividing the weight of organic matter on a constant factor (Schlichting and Blume, 1966).

- N. P. K. and heavy elements content:

The plant needs major mineral elements as it enters into its structure and contributes in its vital processes. Knowledge of the heavy elements helps to know how safe is the compost for germination of vegetable seeds. These elements were tracked by doing the necessary experiments for each element which are shown in Table (1).

Table 1. Methods of metal elements measurements

Method	Metal element
The Caldahl Method (Richard, 1962)	N %
Extraction of ammonium acetate and reading on flame apparatus Flam photometer ELE- (Richard, 1962)	P % Absorbable
	K % Absorbable
Atomic Spectrophotometer Absorption (Mod. 210 VGP) (Mortved *et al*., 1972)	Pb ppm.
	Cd ppm.
	Cr ppm.
	Ni ppm.

2-Greenhouses experiment:

Three adjacent greenhouses have been allocated to cultivate tomato seedlings. Each one has a different treatment (Table 2).

Table 2. Specifications and processing of greenhouses for growing tomato seedlings in every agricultural medium

The number of plants at the greenhouse	Number of lines of agriculture	The symbol	Medium	Width/m	Length/m	Number
600	6	A	%100 compost	8	27	1
1200	6	B Mixture	75% compost+ %25 soil	8	50	2
600	6	C	%100 soil	8	27	3

2-1- First greenhouse preparation (A):

Six lines were prepared at the green house by the tractor. The line was 25-30 cm in deep and 40 cm wide. A 100-cm (non-perforated) polythene nylon strip was opened in the line to cover the surface, (4000 ± 200) kg compost was added to the greenhouse to cover the slides, the width of the compost was exactly 40 cm. After putting the compost on the line covered with polyethylene, the polyethylene was perforated with metal rod to allow water drainage. The space between the lines was not covered with nylon or compost. A drip irrigation system was extended and the compost was irrigated one hour per day for a week before planting, in order to moisten and push the seeds of the herbs to germinate if they are existed, then tomato seedlings, aged 20 days (5/4/2019), were planted at the greenhouse in the middle of the compost.

No need has been shown for fungicides, insecticides and herbicides. After 15 days of cultivation at the greenhouse (20/4/2019), the temperature dropped to less than 14 degrees, the fertilization of high-phosphorus was added at (750 g) and was added again on 20/5/2019, with a balanced fertilizer 20-20-20 (N. P. K.) which contains some rare elements.

2-2- Second greenhouse preparation (B):

Six lines were prepared at the greenhouse by mixing the soil by a shovel at a depth of 15-10 cm and a width of 40 cm. The line was not emptied from its soil, 100 ± 1500 kg of compost was added over the 6 lines. (50 kg) of the compound phosphorus fertilizer and 50 kg of nitrogen fertilizer (urea) were added too. Then mixed with the soil of the line and the lines appeared in the form of terraces.

The lines were well watered and left under the sun for 15 days to sterilize, then the herbaceous plants that appeared during solar ventilation and sterilization were removed by hand.

Tomato seedlings, which are 20 days old, were planted on 5/4/2019. One and a half kilos of high density phosphorus fertilizer was added to each greenhouse on 20/4/2019, and on 20/5/2019 the balanced fertilizer (N. P. K.) was added at a rate of 20-20-20. Since the experiment lasted more than two months and gave tomatoes, high potassium fertilizer was added on 2/7/2019.

2-3- Third greenhouse preparation (C):

Six lines of cultivation were identified at the greenhouse and plowed to a depth of 15 cm, adding 50 kg of compound phosphorus and 50 kg of nitrogen. The Voradane was then added to sterilize the soil and mix it all with the soil of the line with the shovel, forming six lines which were free of compost. The lines are well watered and left under the sun for 15 days to sterilize. The herbaceous plants were removed by hand, and tomato was grown on 5/4/2019. The agricultural practices were provided in terms of adding high phosphoric fertilizer at a rate of 750 g per on 20/4/2019, 15 days after planting. A balanced fertilizer 20-20-20 of (N. P. K.) was added after 45 days of planting on 20/5/2016, and high potassium fertilizer was added on 2/7/2019. All the agricultural practices were applied when needed, and drip irrigation system was performed every two days from the beginning until the end of the experiment.

3-plant material:

The seeds of tomato plants were purchased from a local agricultural pharmacy ***Lycopersicon lycopersicum* L.**

4- Studied traits:

Biological characteristics of the agricultural medium:

Because the aim of the study is the compost composition and its use in vegetable culture, all the changes that occur in the compost and its mixtures were observed and compared, such as the appearance of exotic herbs, as well as the negative effect on the vegetative growth and the roots.

Growth characteristics of tomato plants:

The experiment focused on the length of the vegetative growth as an indicator of the plant's ability to grow on compost as an agricultural medium for tomato, alone or mixed with soil.

The total length of the vegetation was measured from the soil surface (stem contact area with the root) to the highest bud on the plant at the end of the experiment.

Statistical analysis:

The properties of the three medium were compared using the LSD at 0.05 level of probability.

GenStat v12 software was used to study the effect of the main factors on the vegetative traits and soil properties.

Results and discussion:

1- Medium physical properties:

Moisture percentage (%):

After the analysis, the moisture content was determined in the primary material and in the mixtures. The results were presented in Table (3).

Table 3. Percentage of moisture in the medium studied

Medium	Moisture percentage %
100% Compost (A)	51%
75% Compost (B)	33%
100% Soil (C)	18%
(R^2)	0.97

A significant difference was found between the compost and the soil, where the LSD value was 23.335. There was a significant difference between the compost and its mixture with the soil. The compost has been observed with the naked eye and the manual sense that it is disassembled and free from any adhesive, and the heterogeneity of its components in size, which explained by Keith and Greenfield, (2006). However, its addition to the soil improves its physical properties (Gabriela, 2010).

- pH:

The results of the analysis show a clear increase in the pH value of the compost (8.20) which tended to increase in all samples (Table 4). The pH values of the compost were tilted to the alkalinity, while the soil was close in the acidity of the compost with insignificant differences for pH.

The acidity in the mixture was in between. There was a significant difference between the compost and its mixture. The value of R^2 (97%), confirms that 97% of the differences in the acidity values of the mixture are due to the compost in the mixture. Also, the values obtained in Table (4) are in line with Lasaridi *et al.*, (2006) who pointed out that the acceptable minimum tolerances of mature and arable compost as a good medium are acidity (PH=6.3-8.9).

Table 4. Acidity in the agricultural medium studied

Medium	pH
100% Compost (A)	8.2
75% Compost (B)	7.92
100% Soil (C)	7.5
(R^2)	0.97

- Electrical conductivity EC (m mhos/cm):

The value of the electric conductivity was measured for the three mediums. The results show that the value of the electric conductivity in the compost (Table 5) was higher, and therefore the salinity was higher than the soil. There was a significant difference between medium A and C. This corresponds to the results of Manios, (2002), who showed that the compost is highly saline, but it is still within the permissible limits, especially for plants which can live in high concentrations of saline.

However, the value of EC is indicative of the stability of the compost (Chanyasak *et al.*, 1982), and there is no significant difference between the salinity between the medium A and B.

Table 5. Electrical conductivity in the agricultural medium studied

EC m m/cm	Medium
2.5	100% Compost (A)
2.1	75% Compost (B)
1.35	100% Soil 9C)

It is noted that R^2 = 0.98 is high, which means that the simple linear regression of salinity is strongly related to the compost in the soil and that this parameter can confirm that 98% of the variations in the electric conductivity values are due to the compost in the studied mixtures. However, the salinity of the medium can be tolerated by the roots of the tomato plants, as long as other growth elements which are available (Lasaridi *et al.*, 1991).

- Organic matter OM and organic carbon OC

A clear increase in organic and organic carbon content was observed in the compost (Table 6). This is normal, because the components of the waste are mostly cellulose plant organic waste (Garcia *et al.*, 2009). It was noted the superiority of medium A compared to medium C significantly in terms of content of organic matter and organic carbon.

Table 6. Organic matter and organic carbon in the agricultural medium studied

media	OM %	C/N	N%	C%
100% Compost (A)	53.1	14	2.22	31.23
75% Compost (B)	35.2	11.82	1.75	20.7
100% Soil (C)	2.05	6	0.2	1.2

- Carbon ratio of nitrogen C / N:

The natural C/N ratio of the good growth medium is between 1/20 and 1/30, which expresses a large and sufficient value of the total nitrogen necessary for the feeding and activity of microorganisms.

Table (6) shows that C/N ratio at compost is very high (1/14) and good for root growth and spread, and the added nitrogen in quantity is available to the plant at any moment of need; however, this high percentage causes destruction of the agricultural medium during one agricultural season mostly.

The ratio of C/N was increased when mixing the soil with compost. The percentage of organic carbon in the mixture decreased by one third (from 30% to 20%) while the ratio of nitrogen to one-sixth decreased from 2.22% to 0.384%. This decreases microbial activity and increases the degree of stability of the compost in the mixture (Leogrande *et al.*, 2016; Gopinathan and Thirumurthy, 2012).

Finally, it could be said that C/N could be considered as an indicator of compost maturity and stability together (Inbar *et al.*, 1990; Swizenbaum *et al.*, 1997).

2 - Mineral fertilizers content:

- Nitrogen content:

Due to the importance of the nitrogen element in vegetative and root growth, the nitrogen content of the compost and the other elements in the medium were estimated. Table (7) shows that the percentage of nitrogen in the compost is high and is higher than 2% by weight, which is required for good growth and development, while it is low in the soil (0.1%) and its content improved after mixing with compost. This is in line with the studies that have shown that compost improves the content of the agricultural medium of nutrients (Hanafy *et al.*, 2002). Also it was noted that the good compost content of minerals, especially nitrogen, is evidence of compost stability. The statistical analysis showed significant differences between medium A and B. A significant difference was found too between medium A and C. The addition of balanced fertilizer (NPK) at a rate of 20-20-20 provides enough nitrogen for roots. This increases the ability of the medium for root branches and vegetative growth. Inoko *et al.*, 1979 clarified that the total nitrogen intake (N%) should be> 2% based on dry matter.

Table 7. Compost content of the major minerals

Medium	N%	K mg/kg	P mg/kg
A (100% compost)	2.22	11980	82.3
B (75% compost)	0.384	5518	74.3
C (0% compost)	0.108	264.8	

- Potassium content

Table (7) shows the content of the compost and the medium of potassium. It is noted that the measured potassium content (11980 ppm) calculated in the compost and equivalent to (1.2%) is well below the minimum required as mentioned by Lasaridi *et al.,* (2006) to the acceptable minimum limits of potassium in the mature compost is 0. 30% Potash, meaning that the measured ratio is insufficient for growth.

While its percentage in the soil is low (264.84 ppm) and this is due to the high potassium fertilization during the experiment. This complements the results of studies that confirm that soil content of potassium improved after mixing with the compost (Omer *et al.*, 2006). The statistical analysis showed that there was significant difference between medium A and B. Also, there was a significant difference between medium A and C.

- Phosphorus content

The results of the analyzes were presented in Table (7). The compost contains about 80 ppm of phosphorus (0.008%), which is low compared with Zucconi and De Bertoldi, (1987). The minimum percentage of phosphorus in mature compost under alkaline conditions is 0.5% phosphorus (5000 ppm).

The soil has increased its phosphorus content by increasing its compost ratio, which is confirmed by Elena *et al*., (2017). However, the proportion of phosphorus in all mediums is low and insufficient for good growth. This is modified by the addition of phosphoric fertilizer at the early stages of growth, where the results showed that there was a significant difference between medium A and B, and between the medium A and C.

3- Rare elements content:

Table (8) shows a decrease in soil content in medium C of micro-nutrients compared to A and B. The soil content of rare elements has improved after mixing with compost, and this corresponds to the results of Jackson *et al*., (2004). Compost is rich in major and rare nutrients resulting from the decomposition of organic matter through fermentation.

Table 8. Medium content of rare and micro elements

Medium	Fe mg/kg	Cu mg/kg	Mn mg/kg	Zn mg/kg
A (100% compost)	279	89.5	42.1	284
B (75% compost)	110.66	37.4	52.03	129.33
C (0% compost)	10.1	13.2	12.5	3.1

4-Heavy elements content:

The results show that the content of heavy elements was low and within the permissible limits for agricultural (Table 9).

Table 9. Medium content of some heavy elements (ppm)

Item	Cr	Ni	Pb	Cd
The permissible limits according to (No. 3556)	**50**	**2.5**	**50**	**0.5**
Elements in Compost	0.2	0.1	0.3	0.04
Soil	0.059	0.032	0.0028	0.0006

5- Vegetative length (cm) in the three mediums:

It was observed that a month after the start of germination, there was an improvement in the length of the plants on all mediums, but the total vegetative length on the compost declined significantly and the vegetative length of the compost mixture (B) was improved when compared with (A) and (C) (Fig. 1).

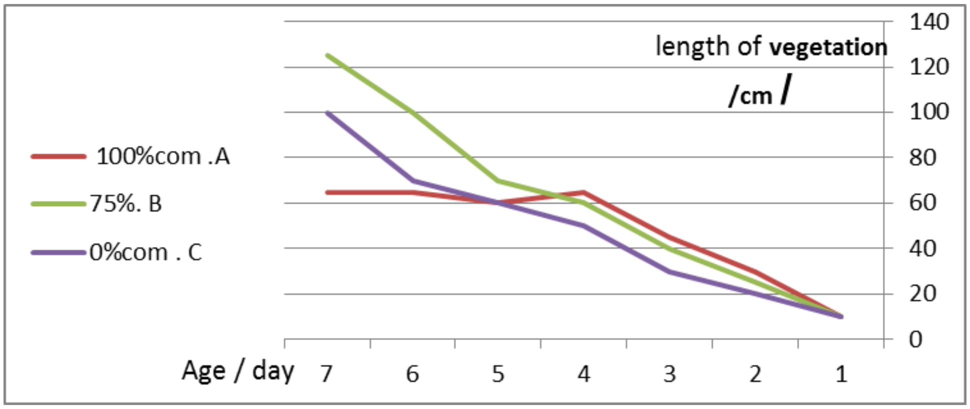

Figure 1. The total vegetative length of tomato plants on the studied mediums (A, B, and C)

- Vegetative length of tomato plants on the medium A (100% compost):

The irrigation was done in greenhouses at the beginning every two days, but the plants suffered from thirst, so the irrigation was done every day. During the first month of the experiment, the seedlings gave a good growth under the conditions of daily watering. The total vegetative length in the medium A became good after changing the duration and time of irrigation from two days to daily irrigation. Dryness of the surface layer of the medium (A) is due to physical reasons of the construction of the compost, and this explains the weakness of its ability to connect or retain water.

However, after about a month and a half, the yellowing and weak growth of the seedlings was observed on this medium (A) and the decline in vegetative growth (Figure 1), besides, all plants died and the experiment failed, and the lack of good growth can be attributed to the characteristics of the medium in terms of the decomposed structure of the compost, and its constant need for irrigation and the relatively high salinity rate in the case of lack of water. R^2 was 0.79, which means that the simple linear regression relationship can account for 79% of the variations in the vegetative length ratio in the medium (A).

- Vegetative length of tomato plants on the medium B (75% compost and 25% soil):

The total vegetative length of the developing plants in the medium B was good compared to the other mediums, with the increase in the length of growth period. The vegetative growth in medium B was the best; indicating that mixing compost with soil (B) improves the vegetative growth of plants (Garcia-Gomez, 2002), and provides plant survival, also, gave the plants a positive impression of its shape and strong construction.

- Vegetative length of tomato plants on the medium C (100% soil):

The total vegetative length on the soil medium (C) was good but less compared to medium (B). Herbs were observed with the need for herbicides. The value R^2=0.97 means that the simple linear regression relationship can explain 97% of the differences in the vegetative length due to the soil in medium (C). I could be concluded that the soil alone is insufficient under experimental conditions to be an appropriate medium for tomato production.

Conclusion:

The results of the study concluded that the advantages of garbage compost were as follow:

- A safe medium for use, transport, culture and free of heavy elements.
- Cheap fertilizer and available in quantity and quality.

Also, the results concluded that the disadvantages of garbage compost were as follow:

- It is needed to be mixed with soil or any substance.
- It is needed highly for irrigation (requires a large quantity of water).

Recommendations:

It is recommended to grow tomato seedlings on the compost directly, but the agricultural mixture (75% compost + 25% soil) is needed for cultivation of tomato seedling at the greenhouses to get good vegetative growth, hence a good production.

References:

Ala-Aldin, H. (1989). Eignung von Hobelspänen und Holzsch- nitzeln in Kultursubstraten für Baumschulgehölze. Dissertation Uni-Hannover. West Germany. German.

Chahin, H. (1996). Solid waste treatment. University book. Department of Environmental Engineering, Tishreen University Publications, 1996. pp. 300

Chahin, H.; and A. Awad (2001). Ecological assessment of solid waste treatment system at Lattakia City. 11th Euro–Arab Conference for the Environment, Rostock, Germany, 24-26 April, 2001, .33-41.

Chanyasak, V.; M. Hirai; and H. Kubota (1982). Changes of chemical components and nitrogen transformation in water extracts during composting of garbage. J. Fament. Technol., 60: 439-446.

Elena cristina rada, lucian-ionel cioca and gabriela ionescu (2017). Energy recovery from municipal solid waste in EU: proposals to assess the management performance under a circular economy perspective, MATEC Web of Conferences, 121, 05006

Gabreala, A. (2010). Physico-chemical and microbiological composition of composts from Bucharest Municipal Waste. Pp 62-66.

Garcia, C.; A. Ruiz-Navarro; N. Garcia-Franco; and G.G Barbera (2009). Effects of organic composts on soil properties: comparative evaluation of source-separated and non-source-separated composts. 1st Spanish National Conference on Advances in Materials Recycling and Eco – Energy Madrid,. 12-13 November. Pp 62-66

Garcia-Gomez, A.; M.P. Bernal; and A. Roig (2002). Growth of ornamental plants in two composts prepared from agro industrial wastes. Bio resource Tech., 83: 81- 87.

Gopinathan, M.; and M. Thirumurthy (2012). Evaluation of Phytotoxicity for compost from organic fraction of municipal solid waste and paper & pulp mill sludge. Environmental Research Engineering and Management. 59(1).

Hanafy, A.H.; M.R.A. Nesiem; A.M. Hewedy; and H.E.E. Sallam (2002). Effect of organic manures, biofertilizers and N.P.K mineral fertilizers on growth, yield, chemical composition and nitrate accumulation of sweet pepper plants. Recent technologies in agriculture. Faculty of Agriculture, Cairo University.

Hesse, P.R.A. (1971). Text book of soil chemical analysis. John Murray London UK. Jackson, M. L., (1958) Soil chemical analysis. Prentice Hall Inc. Englewood. Cliffe N J. Pp 151-153 and 331-334.

Jackson, L.; I. Ramirez; L. Murphree; R. Yokota; W. Chaney; F. Doltt; S. Koike; R. Smith and M. Cantwell (2004). Effect of compost on soils and vegetable production, USA, University of California.

Inbar, Y.; Y. Chen; and Y. Hadar (1990). Humic substances formed during the composting of organic matter. Soil Sci. Soc. Am. J. 54: 1316–1323.

Inoko, A.; K. Miyamatsu; K. Suoahara; and Y. Harada (1979). On some organic constituents of city refuse composts produced in Japan, Soil Sci. Plant Nutr., 25: 225-234.

Keith, R.B.; and J.T. Greenfield (2006). Composting on organic farms collage of agriculture & life sciences North California. The Organic Production Publication Series, the Center for Environmental Farming Systems, E06-45788.

Lasaridi, K.; I. Protopapa; M. Kotsou; G. Pilidis; T. Manios; and A. Kyriacou (2006). Quality assessment of composts in the Greek market: The need forstandards and quality assurance. J. Environ. Manage., 80: 58-65.

Leogrande, R.; C. Vitti; O. Lopedota; D. Ventrella; and F. Montemurro (2016). Saline water and MSW compost: Effects on yield of maize crop and soil responses. Pp. 1863-1873.

Manios, T. (2002). The composting potential of different organic solid wastes experience from the island of Crete, Environment International. 29: 1079 – 1089.

Mortved, J.J.; P.M. Giordano; W.L. Lindsay; R.C. Dinauer; V.S. Clark; and P. Eite (1972). Micronutrients in agriculture. Soil Sci. Soc. Amer., Inc. Madison, Wisconsin. U.S.A,

Ömer, H.D.; K. Gülgün; and Ö Saim (2006). Effects of organic waste substrates on the growth of impatiens. Sakarya University, Turkey. Turk. J. Agric., 30: 375-381.

Richards, L.A. (1962). Diagnosis and improvement of saline and alkaline soils. Agricultural hand book no 60. United States Department of Agriculture.

Schlichting, E.; and H.P. Blume (1966). Bodenkundliches Praktikum. 209 S., 35 Abb., 38 Tab.; P. Parey, Hamburg 1966; Preis: Kartoniert DM 32. DOI: https://doi.org/10.1002/jpln.19671160209.

Zucconi, F.; and M.D. Bertoldi (1987). Compost specifications for the production and characterization of compost from municipal solid waste. In: De Bertoldi, M., Ferranti, M.P., L′Hermite, M.P. and Zucconi, F., Eds., Compost: Production, Quality and Use, Elsevier, London, 276-295.

Switzenbaum, M.S.; L.H. Moss; E. Epstein, A. B. Pincini; and J. F. Donovan (1997). Defining bio solids stability: a basis for public and regulatory acceptance. Water Environment Research Foundation, Alexandria, VA.