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Impact of Organic Fertilizers Derived from Banana and Orange Peels on Tomato plant Quality

[32]

Mona I Nossier
Soils Dept, Fac of Agric, Ain Shams Univ, P.O. Box 68-Hadayek Shoubra 11241, Cairo, Egypt

*Corresponding author: mona_nossier@agr.asu.edu.eg

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Abstract

The main objective of this research is to promote the reuse of wastes resulting from different manufacturing processes such as fruit peels (e.g. banana and orange peels) as substitutes (at least partially) of mineral fertilizers. This might have positive effects in maintaining human health and reducing environmental pollution. Moreover, to compare the use of these wastes with commercial organic fertilizer i.e., compost made by Nile Company to meet the needs of tomato plants from nitrogen (N) and potassium (K) elements. To achieve the goal, two experiments were conducted. The first was an incubation experiment, which was designed to compare the organic fertilizer compost of Nile Company and the powdered banana and orange peels. The second was a field experiment achieved at the Faculty of Agriculture, Ain Shams University. Obtained results of the incubation experiment showed increases in nitrogen content by 16 to 31% and potassium by 12 to 24% due to using grinded banana and orange peels as compared to the compost treatment. Moreover, in the field experiment the concentration of nitrogen (N) and potassium (K) at different plant growth stages whether in soil or plant did not differ significantly between soil plots fertilized with mineral fertilization and those fertilized with banana and orange ones. On contrary, potassium concentration was found higher in the soil fertilized with organic fertilization than that fertilized with mineral fertilization. It has also been found to us that there are no clear significant differences between tomato fruits resulting from mineral fertilization of the ground and those that were fertilized by the mixture of banana and orange peels in terms of the ratio of nitrogen and potassium, weight, size and density of the fruit and other characteristics except for the total salts percentage, which was less Fruits fertilized with a mixture of banana and orange peels.

Keywords: Banana and Orange Peels**;** Compost**;** Tomatoes.

1 Introduction

There are two basic types of fertilization, either organic fertilization or mineral fertilization, and each of them has its advantages and disadvantages, but the basic judgment for us in choosing between them is the health of the human being and the animal feeding on these plants. Therefore, we must be keen on fertilizing the soil in a way that includes us getting the plant, all its needs of plant nutrients, but in a safe manner for human and animal health.

Due to the increasing population in the world, the amount of wastes from food residues increases, and therefore there are tons of these wastes produced annually, which constitutes a burden on countries in how to get rid of these solid and liquid wastes and these causing environmental problems (Divina, 2016).

World Bank report estimated that between 2009 and 2030, food demands will increase by 50% as the population grows, and consequently will require greater food production and processing. Unfortunately, not all food produced in the fields end up in the tables to feed the population, but a great amount eventually becomes food waste (Menas et al 2011).

Fertilizers are either inorganic or organic material of natural or synthetic origin that is added to a soil in order to supply one or more plant nutrients that are essential to the growth of plants. Fruits contain high amounts of antioxidants that are beneficial to human health in many ways (Faria et al 2006; Hiral et al *(*2016).

Most plants need a certain amount of these top three macronutrients: nitrogen, phosphorus, and potassium. Some plants are more needful of nitrogen, while others are more needful of phosphorus, and still others need a higher level of potassium (Kristi, 2018). Fruits peels contain the most incredible nutrients in the world. There are many health benefits of both orange and banana peels that are unknown (Iram, 2015).Banana peels; it contains also manganese which helps in photosynthesis process; sodium, which helps in the movement of water between cells; especially some potassium loving plants need. and magnesium and sulfur, both of which are helpful in the formation of chlorophyll, also contain calcium, which helps plants to take up more nitrogen (**Kristi**, **2018).** Banana peels are particularly effective for use as a natural fertilizer. Also banana and orange peels can add nutrients to the soil as they decompose. They rot quickly if burying them, offering rich stores for vital nutrients to the soil, including, magnesium, calcium, phosphorus, sulfur, potassium, and sodium. In addition, dried and grinded peels can be used as mulch, or applying directly to planting areas **(Caryn, 2018).** Also, banana peels are a fantastic source of organic potassium and loads high in potassium than even wood ash (Kristi, 2018).

2 Materials and Methods

This study was carried out to study the effect of dried and grinded banana and orange peels treatments (without converting them to compost) on the concentration of N and K by tomato plants at different growth stages, and how this treatments affect the quality of its fruit. To achieve this, two experiments were conducted. The first was a laboratory incubation experiment, and the second was a field experiment.

2.1. Incubation experiment

This experiment was conducted mainly to compare the effect of processed plant compost (Nile Company) and the effect of dried and grinded banana and orange peels on the availability of N and K in soil at successive time intervals. The Nile Company Compost was subjected to elemental analyses and the data are given in **(Table 1)**.

Also some analyses were conducted on the dried and grinded peels of bananas and oranges. The analyses results are shown in **(Table 2)**.

Table 1. Some chemical analyses of the Nile Company compost

Element	N	P	K	Fe	Zn	Mn	%O.C
Concentration (ppm)	17.2	3.6	13.9	1500	54.4	140	28.5

Table 2. Some chemical analyses of the studied fruits peels

Element conc. (ppm)	N	P	K	Fe	Zn	Mn	%O.C
Orange peels	9.40	2.33	7.90	1.15	0.12	0.04	46.24
Banana peels	11.40	2.89	24.40	1.18	0.06	0.50	37.00

A sand washed medium was prepared and 300g of it was put in a pot and mixed thoroughly with a given treatment as follows:

A- 40g of Nile Company compost.
B- 20g of banana and orange peels.
C- 40g of banana and orange peels.
Each treatment was replicated three times.
Samples from each pot were taken at successive intervals (i.e. zero, one, two, four and eight weeks). Available N and K concentrations were then determined immediately after each sampling time.

2.2. Field experiment

A field experiment was conducted at the Faculty of Agriculture, Ain Shams University. Some physical and chemical analyses of the studied soil site are shown in **(Table 3)**.

Table 3. Some physical and chemical analyses of the studied soil sample

Particle size distribution, %	
C. Sand	14.5
F. Sand	19.5
Silt	33.7
Clay	32.3
Texture class	Silt Clay
pH (1:2.5 soil: water suspension)	7.9
EC_e, dS m^{-1}	4.4
Soluble cations, meq L^{-1}	
Ca^{2+}	13.4
Mg^{2+}	6.6
Na^+	23.3
K^+	0.7
Soluble anions, meq L^{-1}	
CO_3^{2-}	0
HCO_3^-	1.2
Cl^-	40.1
SO_4^{2-}	2.7
Concerned available elements, ppm	
N	50
P	0.9
K	120

Before planting of tomato seedlings, the soil was fertilized with both composting animal waste fertilizer (80kg/32m^2) and super phosphate fertilizers (16kg/32m^2). Afterwards, the experimental soil was divided into four agricultural lines, the area of the line (8m*70cm), the distance between lines 30cm and the distance between plants 10cm. The first and second lines were fertilized with mineral fertilizers in the usual quantities and considered as control treatment. The third and fourth lines were fertilized with grinded banana and orange peels **(Table 4)**, in quantities that meet the nutrient needs of the plant based on the result of the above analysis (**Table 2).**

Two extracts from banana peels were collected and their mineral contents was determined and given in (**Table 5**).

These extracts were used to spray tomato plants before and during the flowering stages directly. Soil and plant samples were collected during the physiological growth stages of tomato plant and nitrogen, phosphorus and potassium were determined at each stage.

2.3. Methods of analysis

2.3.1. Soil analysis

Soil samples were collected before plant cultivation, The abovementioned soil were sampled at a depth of 0 to 20 cm air dried, ground and sieved through a 2mm sieve, finally preserved for the following analysis according to Jackson (1973) and Baruah and Barthakur (1997).

Soil mechanical analysis was carried out by the pipette method using sodium hexametaphosphate as a dispersing agent.

The soil available N, P and k were extracted by 1% K_2SO_4, 0.5 N $NaHCO_3$, and 1 N NH_4OAc (pH 7.0), respectively (Black, 1965; Jackson, 1973).

2.3.2. Plant analysis

The plant samples dried at 70^{o}C were wet digested with a mixture of H_2SO_4 and H_2O_2 according to Cottenie et al (1982).

- Total nitrogen content in plant was determined by micro kjeldahl method using 5% boric acid and 40% NaOH as described by Black et al (1965).
- Total potassium was determined using Flame photometer (Jackson, 1973).
- Total phosphorus was determined using spectrophotometer.
- Lycopene was determined using rapid extraction of lycopene and β-carotene from reconstituted tomato paste and pink grapefruit homogenates (Sadler et al 1990)
- Anti-oxidant capacity of flavonoids from Licanialicaniaeflora (Bors, 1992; Braca, 2002).

A total soluble solid of the tomato juice was measured by the method described by Tigchelaar (1986).
- The pH of the tomato juice was determined by the method described by Rangana (1979).

2.3.3. Statistics program for statistical analysis (T- test in pairs- SAS- test)

The obtained data were statistically analysed using SAS software package. The means that were significant were separated using Duncan's multiple range test at P=0.05 (SAS, 2006).

Table 4. Rates of mineral and organic fertilizers added during tomato growth according to plant's needs

<table>
<tr><th>Time (week)</th><th></th><th>Control soil</th><th>Treated soil</th></tr>
<tr><td rowspan="2">1</td><td rowspan="6">vegetable growth</td><td colspan="2">16kg/ 32m^2 super phosphate + 80kg/32m^2 compost fertilizer</td></tr>
<tr><td></td><td>500g banana +1000g orange dry peels</td></tr>
<tr><td>2</td><td colspan="2">Agriculture date</td></tr>
<tr><td rowspan="2">3</td><td></td><td>200g banana +1000g orange dry peels</td></tr>
<tr><td colspan="2">16kg/ 32m^2 super phosphate</td></tr>
<tr><td>4</td><td>1.5kg/ 16m^2 urea</td><td></td></tr>
<tr><td rowspan="2">5</td><td rowspan="4">Floral growth</td><td colspan="2">16kg/ 32m^2 super phosphate</td></tr>
<tr><td>1.5kg/ 16m^2 urea</td><td></td></tr>
<tr><td>6</td><td></td><td>300g banana + 300g orange dry peels + extract solution from 500g banana peels/3L water</td></tr>
<tr><td>7</td><td></td><td>spry extract solution from 500g banana fresh peels/3L water</td></tr>
<tr><td>8</td><td rowspan="3">Fruit growth</td><td></td><td>spry extract solution from 1000g banana fresh peels/ 3L water</td></tr>
<tr><td>9</td><td></td><td>spry extract solution from 1000g banana fresh peels/ 3L water</td></tr>
<tr><td>13</td><td>(1.5kg $Ca(NO_3)_2$ + 800g K_2SO_4)/ 16m^2</td><td></td></tr>
</table>

Table 5. Some chemical analyses of the two extracts from banana peels

Element	N	P	K	Fe	Zn	Mn
B1 (0.5kg banana peels/ 3L water)	16.3	1.4	2.5	0.299	0.469	0.243
B2 (1.0kg banana peels/ 3L water)	23.4	2.6	4.1	0.681	0.581	0.396

3 Results

3.1. Incubation experiment

In this experiment, a decrease in the percentage of nitrogen and potassium was observed with the passage of time, and this was due to the activity of microorganisms on the analysis of these residues (compost fertilizer - banana and orange peels), but it was clear that there was a significant increase in the ratio of nitrogen and potassium facilitated in the soil treated with banana and orange peel compared to the soil that treated with compost **(Tables 6 and 7)**.

3.2. Field experiment

3.2.1. Results of soil analysis

It was observed that there was an insignificant increase in the ratio of nitrogen and potassium in the soil treated with banana and orange peels compared to the control treatment, while phosphorus was low compared to control in the vegetative growth phase, the ratio of nitrogen and potassium in the ground treated with banana and orange peel was observed increase while phosphorus was low compared to control treatment in the floral growth, it was observed that there was an insignificant increase in the ratio of potassium in the soil treated with banana and orange peels compared to the control, while the ratio of nitrogen not increased significantly but phosphorus was low compared to control in the fruit growth stage.

3.2.2. Results of plant analysis

The percentage of N, K and P in the vegetative growth of tomato plant grown in the soil that treated by banana and orange peels was observed increase as compared to control treatment in the vegetative growth, The percentage of N, K and P in the vegetative growth of tomato plant grown in the soil that treated by banana and orange peels was observed increase as compared to control treatment in the floral growth, for nitrogen, there was no significant difference between the two treatments in the fruit growth stage but gave higher values in potassium and phosphorus as compared to control treatment in the growth stage.

Table 6. Effect of fertilization with banana and orange peels on nitrogen availability compared to compost

Time (week)	**0**	**1**	**2**	**4**	**8**
Treatments	**N (ppm)**				
Compost	188.6 ABC	144 BDC	127.3 DES	110.3 DE	65.6 E
T 20	212.3 AB	123.3 DEC	205.6 AB	112 DEC	111 DE
T 40	238.3 A	140 BDEC	243.6 A	119.6 DEC	187.3 ABCD

Means with the same letters are not significantly different.
T 20: 10g orange peels + 10g banana peels; T 40: 20g orange peels + 20g banana peels.

Table 7. Effect of fertilization with banana and orange peels on potassium availability compared to compost

Time (week)	**0**	**1**	**2**	**4**	**8**
Treatments	**K (ppm)**				
Compost	662.2 ED	530 EF	438.4 F	805.5 BCD	618.7 E
T 20	673.3 ECD	601.3 E	562.8 EF	823.1 BC	810.9 BCD
T 40	873.5 B	628.6 E	635.9 E	1030.3 A	888.2 AB

Means with the same letters are not significantly different.
T 20: 10g orange peels + 10g banana peels; T 40: 20g orange peels + 20g banana peels.

Table 8. Effect of fertilization with banana and orange peels on the concentration of nitrogen, potassium and phosphorus as compared to control treatment

Measurements and treatments		Means values	T Value	Pr> (T)
Vegetable growth stage (N)	Control	120.0		
	Treatment	193.0	1.80	0.02
Vegetable growth stage (P)	Control	2.4		
	Treatment	1.3	2.50	0.12
Vegetable growth stage (K)	Control	294.8		
	Treatment	339.5	0.90	0.46
Floral growth stage (N)	Control	162.0		
	Treatment	175.0	0.27	0.81
Floral growth stage (P)	Control	10.1		
	Treatment	6.2	1.25	0.33
Floral growth stage (K)	Control	372.6		
	Treatment	390.1	0.96	0.43
Fruit growth stage (N)	Control	123.5		
	Treatment	125.0	0.01	0.99
Fruit growth stage (P)	Control	2.8		
	Treatment	1.8	1.53	0.26
Fruit growth stage (K)	Control	169.0		
	Treatment	221.0	8.12	0.01

Pr> (T) 0.05 not significant.

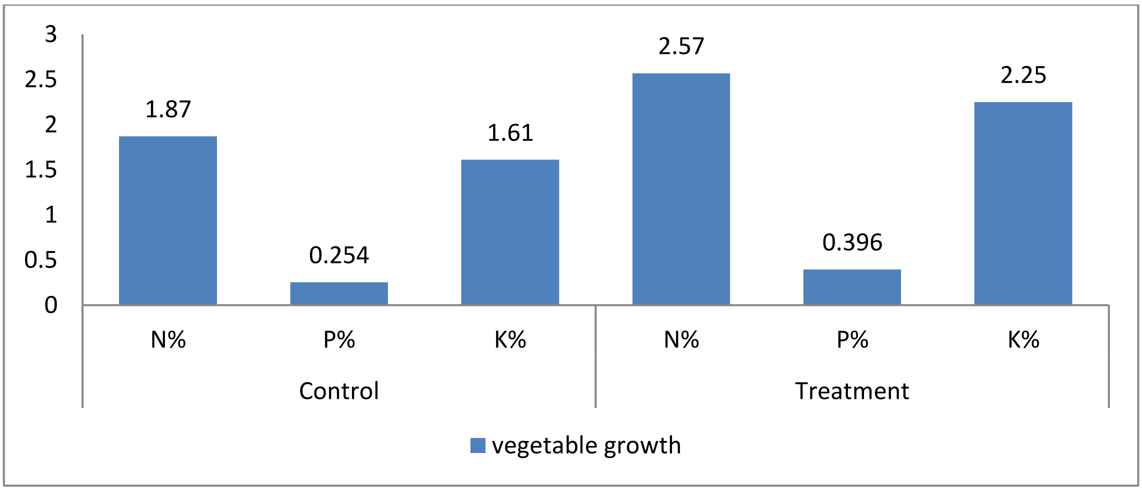

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Fig 1. Effect of fertilization on banana and orange peels on the concentration of nitrogen, potassium and phosphorus as compared to control at the vegetative growth stage

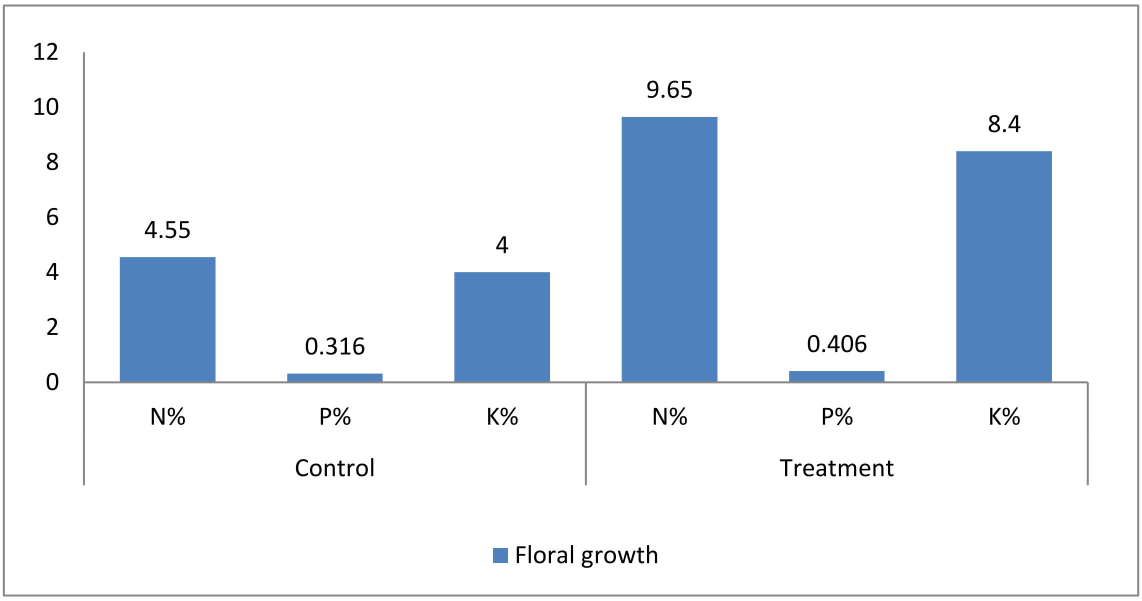

Fig 2. Effect of fertilization with banana and orange peels on the concentration of nitrogen, potassium and phosphorus as compared to control at floral growth stage

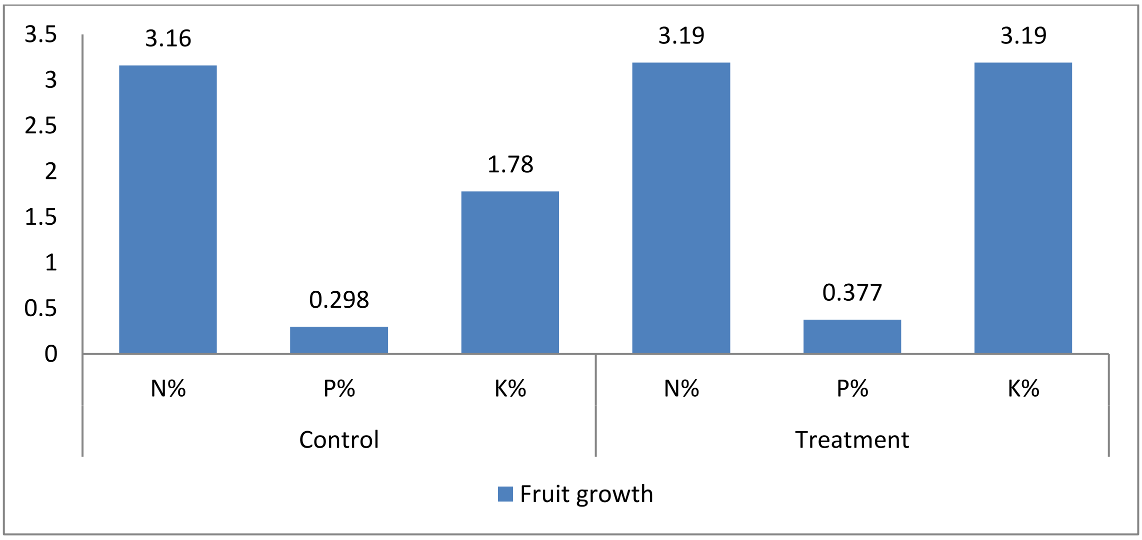

Fig 3. Effect of fertilization with banana and orange peels on the concentration of nitrogen, potassium and phosphorus as compared to control at the fruit growth stage

Table 9. Effect of banana and orange peels fertilization on the nutrients content of tomato fruits

Element (%)	Control	Treatment
N	3.5 a	2.66 ab
P	0.439 a	0.443 a
K	1.89 a	1.87 a

Table 10. Effect of banana and orange peels fertilization on the quality of tomato fruits compared to control treatment

Measurements and treatments		Mean Values	T Value	Pr> (T)
Weight (g)	Control	81.2	1.23	0.29
	Treatment	71.5		
Volume (cm^3)	Control	52.4	1.18	0.31
	Treatment	71.2		
Fruit Density (g/cm^3)	Control	0.89	195	0.12
	Treatment	0.93		
Total Water content (%)	Control	87.8	2.14	0.09
	Treatment	86.3		
True Acidity (pH)	Control	4.1	0.84	0.44
	Treatment	3.6		
TDS (mg/ l)	Control	3906.7	8.32	0.001
	Treatment	3026.7		
Lycopene (mg/g fresh wt.)	Control	50.5	0.13	0.91
	Treatment	50.3		
Anti-Oxidant Capacity	Control	55.9	4.04	0.015
	Treatment	48.3		

Pr> (T) 0.05 not significantly

3.2.3. Results of tomato plant analysis

It is noted that there were no significant differences in the standards for the quality of tomato fruits between the treatment of banana and orange peel and control treatment except in the TDS (mg/ L).

4 Discussion

Previous results obtained indicate that mineral fertilizers can be substituted with organic fertilizers resulting from the use of banana and orange peel where it was observed the convergence of the results obtained and the absence of any significant differences when fertilizing banana and orange scales or fertilization with the usual mineral fertilizer used, on the contrary, there was an increase in the potassium ratio at each stage of tomato plant growth when fertilizing with banana and orange peel.

It was also observed that there were no significant differences in the quality of the fruits of the tomato plant according to both methods in fertilization high in the quality of tomato fruits fertilized with banana and orange peel, especially in the proportion of total salts and acidity were less than the control.

The reason is that banana and orange peel is rich in many plant nutrients during its various stages of development. Several studies have confirmed the richness of fruits and vegetables with a variety of nutrients.

Both have been explained (Tsay et al 2004; Mercy et al 2014a), it has become common recently that use fruit and vegetable peels as fertilizer for the soil, as the efficiency and fertility of the soil have increased by using different formulations of organic fertilizers with fruit peels, as there has been an increase in the various types of microorganisms suitable for plant growth in the soil. It has been observed that the increase in the elemental content of the earth is due to the fact that these crusts are rich in elements necessary for the soil and plant growth.

Mercy et al (2014b) emphasized in their research that the fruit peels of banana, sweet lemon, orange and pomegranate are very rich in iron, potassium, zinc and many other elements that increase soil fertility and thus increase the growth and health of the plant.

Hiral et al (2016) have confirmed in their research that the use of powdered fruit peels such as bananas, oranges, pomegranates, and others can be used as fertilizer for the ground, regulating the pH and supplementing some nutrients such as zinc, iron and calcium, and they emphasized that the use of these peels in fertilization does not require a high cost and thus it also helps in transferring waste into usable materials.

5 Conclusion

It can be conclude that the trend towards recycling of organic wastes such as peel fruits and vegetables and fertilizing the soil, where it was found that this method is easier to apply and does not take a long time or high cost as it has not any obstacles, not producing any smells, does not need to allocate specific places for the manufacturing and processing compared to the traditional compost or mineral fertilizer, (from the soil and back to the soil).The study recommend more detailed studies on the utilization of agricultural wastes (e.g. fruits peels) . In this concern, it is recommended to collect fruits peels from factories, drying, grinding and then add with the municipal fertilizer to the soil two weeks before planting. It is also preferable to calculate the plant needs of the nutrients and accordingly add the appropriate quantities of dried banana and orange peel to meet its needs.

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تأثير الأسمدة العضوية المشتقة من قشور البرتقال والموز على جودة نبات الطماطم

[32]

منى إبراهيم نصير*

قسم الآراضي – كلية الزراعة – جامعة عين شمس – ص.ب 68 – حدائق شبرا 11241 – القاهرة – مصر

*Corresponding author: mona_nossier@agr.asu.edu.eg

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الهدف الأساسي من هذا البحث هو تعزيز إستخدام المخلفات الناتجة من عمليات التصنيع الغذائي المختلفة مثل قشور الفواكه خاصة قشور البرتقال والموز الناتجة من عمليات تصنيع العصائر فى التسميد العضوي للنباتات بدلاً من التسميد المعدنى خاصة بعد ثبوت مدى غنى هذه القشور بالعناصر الغذائية الأساسية والضرورية للنباتات. هذا بالطبع له تأثير إيجابى فعال فى الحفاظ على صحة الإنسان والتقليل من التلوث البيئى نتيجة إعادة تدوير هذه المخلفات. ومن هذا المنطلق تم تجميع قشور الموز والبرتقال ثم تجفيفهم على درجة حرارة 70°م ثم طحنهم وإخضاعهم لعدد من التحليلات للكشف عن نسب العناصر بهم، وفى نفس الوقت تم إختيار نبات الطماطم لأجراء هذه التجربة عليه حيث قد تم حساب الإحتياجات الغذائية له من كل عنصر من العناصر الضرورية خاصة عنصري النيتروجين والبوتاسيوم. وقد أجريت التجربة على مرحلتين، الأولى هى تجربة تحضين أقيمت بغرض عمل مقارنة بين سماد عضوي دارج إستخدامه وهو كمبوست شركة النيل وبين السماد المُحضر من قشور الموز والبرتقال المجفف وذلك بهدف تتبع تركيزات عنصري النيتروجين والبوتاسيوم على عدة أزمنة متعاقبة. أما المرحلة الثانية فكانت عبارة عن إجراء تجربة حقلية فى صوبة كلية الزراعة، جامعة عين شمس حيث قسمت الأرض إلى قطعتين الأولى تم تسميدها بالتسميد المعدنى المعتاد والأخرى تم تسميدها بقشور الموز والبرتقال المجففة وقد أخذت عينات أرضية ونباتية للتحليل على فترات نمو النبات المختلفة. أبرز النتائج المتحصل عليها خلال هذه التجربة أن تركيز عنصري النيتروجين والبوتاسيوم خلال مراحل نمو النبات سواء فى الأرض أو النبات لم يكن فيها أي إختلاف معنوي ما بين الأرض المُسمدة بالتسميد المعدنى وتلك المُسمدة بقشور الموز والبرتقال بل على العكس من ذلك فى بعض مراحل نمو النبات كان تركيز عنصر البوتاسيوم أكبر فى الأرض المُسمدة بالتسميد العضوي عن تلك المُسمدة بالتسميد المعدنى. أوصت الدراسة بالاتجاه نحو إعادة تدوير المخلفات العضوية مثل قشور الفواكه والخضروات من خلال تجفيفها ثم طحنها وتسميد الارض بها حيث وجد أن هذه الطريقة أسهل فى التطبيق ولا تاخذ مدة زمنية كبيرة أو تكلفة عالية، كما أنه لايوجد لها آية معوقات ولا تصدر منها آية روائح ولا تحتاج إلى تخصيص أماكن محددة لتصنيعها وتجهيزها بعكس ما يحدث أثناء تصنيع الكمبوست العادي وبالتالى فإن لهذه الطريقة أهمية بيئية وإقتصادية عالية.