

## EFFECT OF SULPHUR ADDITIVES ON THE CHEMICAL COMPOSITION OF COMPOST

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**ABSTRACT :** *This study was carried out at green house of Soil Science Department, Faculty of Agriculture, Menoufia University, Shebin El-Kom, Egypt to study the effect of different sulphur (S) additives on the chemical properties and the content of available macro-and micronutrients in the compost produced from maize stalks at different composting periods. Four piles of fine maize stalks and farmyard manure with mixed ratio of 65:35 by weight were tested. These piles were treated with S at rates of 0, 1, 2 and 3 % based on the dry weight. The piles were moisted at 60 % WHC of the composted organic materials and aerated every 15 days. Samples of each pile were taken at 0, 20, 40 and 60 days of composting and analyzed for their chemical properties and the content of available macro and micronutrients.*

*The obtained data show that, increasing of both added S and composting period induced a decrease in organic matter (OM) content and pH in the compost, but the content of total N (%) and EC were increased. So, C/N ratios become most narrow in the treatment of 3 % S at 60 days of composting. In addition, the produced compost content of available macronutrients (N, P, K, Ca, Mg and S) and micronutrients (Fe, Zn, Mn and Cu) were augmented with the increase of added S and composting period. These findings mean that, S additives to the composted organic materials improved the compost properties and quality.*

**Key words:** *Compost, Sulphur, Maize stalks, Composting period and Compost properties.*

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### INTRODUCTION

Composting transforms organic waste into a more uniform and biologically stable product that can act as slow release source of plant nutrients. Compost is an economic and safe way for treatment of organic waste and has high concentrations of organic matter and available nutrients (Verma, 2013 and Razikordmahalleh, 2014). The application of organic wastes with a high organic matter content, such as fresh and composted urban wastes, shredded and composted plant materials derived from municipal landscape (Walker and Dawson, 2003), and cotton gin compost and poultry manure (Tejada *et al.*, 2006) to semiarid soils has become a common environmental practice for soil restoration, maintaining soil organic matter, reclaiming degraded soils, and supplying plant nutrients. Marwa (2007) found that, the organic matter in soil play an important role through building up soil aggregates and enhancing proper soil

physical and chemical properties. The application of organic matter to examined sand soil improved its physical as well as chemical and fertility properties.

Sulphur is recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium in crop productivity. It is a consistent of sulphur containing amino acids (Cysteine and methionine) which are building blocks for essential protein in the plant. Moreover, it is essential for good vegetative growth and bulb development in plant and it has a strong influence on potato flower and pungency through involvement in the volatile S-compounds (Anwar *et al.*, 2001; Havlin *et al.*, 2004 and Forney *et al.*, 2010). Sulphur transformations on a per-unit-weight basis are often greater in organic horizons because of the concentration of microbial activity, and transformation rates also tend to be greater in organic horizons (Strickland *et al.* 1987). However, total

transformations actually may be greater in lower mineral horizons due to the greater mass of soil present (Strickland *et al.* 1987 and Schindler *et al.* 1986).

Organic matter decomposition rates vary with chemical makeup and complexities, and whether net S mineralization occurs depends upon the S supply and microbial demand. If more S is available to the system than needed to meet S requirements of sulphur-using microorganisms, mineralization will occur. If less S is available than needed, all S entering the system will become immobilized because microbial needs must be satisfied first. Consequently, in systems where S is limiting, a larger percentage of total S is found in microbial biomass than in systems where S is not limiting (Strick and Nakas, 1984).

This study represented one trail must be carried to improve and increase the compost quality. This trail is summarized in treated the composted organic materials by elemental sulphur (S) during composting process. The effect of different S additives on the compost chemical properties and its contents of available macro- and micronutrients were determined.

## **MATERIALS AND METHODS**

The study was carried out at green house of Soil Sci. Dept., Fac. of Agric. Menoufia Univ. Shebin El-Kom, Egypt to study the effect of S additives and composting period on the chemical properties of the composted organic materials.

### **Composted organic materials**

The used two organic wastes are: -

- a) **Maize stalks (MS).** Samples of MS were collected, spreaded in the open-air conditions for dryness. Then chopped into 2-4 cm segment using rushing machine.
- b) **Farmyard manure (FYM).** Air dried FYM was obtained from the Animal Breeding Farm, Faculty of Agriculture, Menoufia University, Shebin El-Kom

### **Elemental sulphur (S)**

This material which supplied by El-Help company, Egypt. 99% of purity sulphur and pH (1:5 suspension) = 6.42.

### **Composting process**

Each type of the used organic wastes was cut to small pieces (2-4 cm) and arranged in 6 equal height layers proliferate good conditions for aeration and decomposition processes which was used four piles (A, B, C and D) were made from mixture of chopped maize stalks and FYM as organic activators at ratio of 65:35 by weight.

- **Pile "A"** without sulphur additives (CS0).
- **Pile "B"** mixed with 1 % sulphur (CS1).
- **Pile "C"** mixed with 2 % sulphur (CS2).
- **Pile "D"** mixed with 3 % sulphur (CS3).

The compost was prepared in polyethylene pots of 50 cm diameters, and 70 cm depth, Each pot contained about 20 kg of air dried mixture maize stalks and FYM. An activating mixture containing about 3.2g Ca(H<sub>2</sub>PO<sub>4</sub>), 10g CaCO<sub>3</sub> 0.32g urea and 100 ml of fresh fertile soil-water suspension (1:5) was added. Each pile was properly moistened to reach about (50- 60%) of its water holding capacity and left to decompose until 60 days. The piles were turned upside down every 15 days starting from the top and sides into the center to enhance the aerobic decay process. Additional water was sprayed during the turning process to keep moisture content of each pile at almost 60 % of water holding capacity. The organic wastes were satisfactorily decomposed by this method after 60 days (Aiad, 2010). Representative sample of heaps were manually taken after 0, 20, 40 and 60 days. These samples air dried ground and analyzed for chemical properties (pH, EC and its content of OM and its Total-N) and the content of available macronutrients (N, P, K, Ca, Mg and S) and micronutrients (Fe, Zn, Mn and Cu) according to the methods described by Cottenie *et al.* (1982) and Page *et al.* (1982).

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### RESULTS AND DISCUSSION

#### - Effect of Sulphur Additives and Composting Period on Compost Properties.

##### - Compost pH

The presented data in Table (1) reveal the pH value of maize stalk compost treated by different additives of elemental sulphur "S" and its relative change "RC" (%) at different composting periods "CP". At the same rate of sulphur additives, compost pH was decreased with increasing the CP; All RC values (%) of pH in relation with CP were negative. This finding is in harmony with that obtained by Aiad (2010) who mentioned that, the pH dropped from 8.15 to

7.63 after 15<sup>th</sup> days of composting. Because of H<sup>+</sup> produced by nitrification and organic neutralization. In, this respect Gu *et al.* (2011) obtained a similar result with the compost produced from different organic materials.

Regarding to the data of compost pH in relation with S additives, the data in Table (1) display that, pH value of compost decreased with the increase of added S. This decrease effect of S additives on compost pH may be ascribed to oxidation of elemental S to solve in the moisture content and forming H<sub>2</sub>SO<sub>4</sub> that resulted in diminishing compost pH.

**Table (1): Effect of sulphur "S" additives and composting period "CP" (day) on compost pH, EC (dSm<sup>-1</sup>) and organic matter content (OM) and their relative changes (RC %) in relation with sulphur additives.**

Treatment of sulphur	Composting period "CP" (day)									
	0		20		40		60		Mean	
	Value	RC %	Value	RC %	Value	RC %	Value	RC %	Value	RC %
	pH 1:10 (compost : water) susp.									
CS0	7.95	0	7.75	0	7.33	0	6.88	0	-	-
CS1	7.87	-1.01	7.69	-0.84	7.35	0.27	6.88	-0.07	-	-
CS2	7.78	-2.14	7.58	-2.26	7.30	-0.34	6.78	-1.45	-	-
CS3	7.78	-2.14	7.49	-3.42	7.28	-0.68	6.64	-3.49	-	-
Mean	-		-		-		-		-	
	EC 1:20 (compost : water) extract (dSm <sup>-1</sup> )									
CS0	1.58	0	1.68	0	1.85	0	2.24	0	<b>1.84</b>	<b>0</b>
CS1	1.62	2.53	1.75	4.17	1.96	5.95	2.54	13.39	<b>1.97</b>	<b>7.07</b>
CS2	1.65	4.43	1.80	7.14	2.15	16.22	2.63	17.41	<b>2.06</b>	<b>11.97</b>
CS3	1.69	6.96	1.97	8.33	2.30	24.32	2.74	22.32	<b>2.17</b>	<b>18.10</b>
Mean	<b>1.63</b>		<b>1.79</b>		<b>2.06</b>		<b>2.54</b>		<b>2.01</b>	
	OM (%)									
CS0	49.57	0	47.50	0	44.22	0	42.65	0	<b>45.99</b>	<b>0</b>
CS1	49.31	-0.52	46.65	-1.79	43.15	-2.42	41.55	-2.58	<b>45.17</b>	<b>-1.78</b>
CS2	48.88	-1.39	45.22	-4.80	42.44	-4.03	40.10	-5.98	<b>44.16</b>	<b>-3.97</b>
CS3	48.38	-2.40	42.84	-9.81	40.11	-9.29	38.50	-9.73	<b>42.46</b>	<b>-7.67</b>
Mean	<b>49.04</b>		<b>45.55</b>		<b>42.48</b>		<b>40.70</b>		<b>44.44</b>	

CS0 = compost without sulphur, CS1= compost with 1% sulphur, CS2 = compost with 2 % sulphur, CS3 = compost with 3 % sulphur.

Roig *et al.* (2004) found that, the addition of S to composted organic materials led to decrease of the pH level within the range 6.0-6.3 which was lower than the control treatment. Addition of sulphur an acidic chemical substance could effectively reduce pH at a relatively lower cost.

- **Compost EC (dS m<sup>-1</sup>)**

The presented data in Table (1) point out the compost EC and its relative change "RC" values (%) in relation with composting period "CP" and different S additives, Compost EC (dSm<sup>-1</sup>) was increased with the CP extended: prolonged increase in EC of composted organic materials could be due to increase the release of different ions such as Na, Ca, Mg and PO<sub>4</sub> resulting from the microbial decomposition of easily decomposable materials (Aiad, 2010 and Belal, 2011). El-Nadi *et al.* (1998) reported that, the high values of EC recorded during the decomposition may be due to increase of released soluble inorganic ions during mineralization process. The EC of the fresh cow manure range formed 2.2 to 4.0 dS m<sup>-1</sup> which implied that, the concentration of soluble salts was in the non-phytotoxic range (Iannotti *et al.*, 1994). So, all values of RC for compost EC with the increase of CP were positive and become more positive at the end of CP. The increase of compost EC and their positive RC values associated the CP increase were occurred with different S.

At the same composting period, increasing the elemental additives of S to composted organic materials appeared an increase in compost EC (Table, 1). These findings may be attributed to oxidizing effect of added S on the composted organic materials followed by increase of many mineral and organic compounds released. These findings also were found at different composting period. In this respect Roig *et al.* (2004) found that a concentration of 0.5 % in sulphur (dry weight basis) and moisture of 40.0 % were proposed as the optimum conditions to decrease the compost pH by

1.1 units without increasing in EC to levels that may suppose a limitation for agricultural use.

- **Organic matter (OM)**

The presented data in Table (1) elucidate that, prolonging composting period in the composted maize stalks was associated by a decrease of compost content of OM (%). therefore, the RC (%) values of OM content as affected by CP were negative. The decrease in OM content may be due to loss of carbon and CO<sub>2</sub> via microbial oxidation during the composting process. This also could be due to the great of action of the carbon consumed by the organisms which is converted into CO<sub>2</sub> and released to atmosphere Wong *et al.* (2001). A similar result was also reported by Aiad (2010) and Belal (2011) found similar decrease of composting organic wastes content of OM, where this decrease was related greatly with the source of composted organic wastes and their initial chemical composition.

At the same composting period, the content (%) of OM in the composted organic materials was decreased with the increase of added S (Table, 1). So, all RC (%) values of OM content as affected by increase of S additives were negative and become more negative at high application rate of S. The found decrease of compost content of OM as a result of S additives could be due to high rate of oxidation resulted from S presence.

- **Total nitrogen (TN)**

The data listed in Table (2) reveal that, at the same treatment of elemental S, elongation the composting period "CP" occurred by an increase of total N (%). For example, the compost content of total N in the treatment free of S was increased from 1.20 % at zero time of CP to 1.6 % after 60 day of CP. In addition, all RC values of total N content as affected by composting period were positive and increased with the CP increase. Aiad (2010) found that, there is an

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increase of total N with the increase of CP, but the rates of these increases were related with the source of the composted organic materials and activators used. In this respect, Kenawy (2003) and Nasser (2007) obtained a similar result.

In addition, the data in Table (2) clear that, sulphur additives to composted organic materials resulted in an increase in total N content (%) of compost particular at the end of composting period with 3 % S. Gu *et al.* (2011) indicated that addition of S could increase the concentration of NH<sub>4</sub>-N and reduces loss of nitrogen.

**Table (2): Effect of sulphur additives and composting period"CP" (day) on total- N (T-N), OC content % and C/N ratio in the compost and its RC % as affected by sulphur additives**

Composting period (day)	Treatment of sulphur	T-N		OC		C/N ratio	
		%	RC	%	RC	value	RC
0	CS0	1.20	0	28.75	0	23.96	0
	CS1	1.18	-1.67	28.60	-0.52	24.24	1.16
	CS2	1.18	-1.67	28.35	-1.39	24.03	0.28
	CS3	1.17	-2.50	28.06	-2.4	23.98	0.10
Mean		<b>1.18</b>		<b>28.44</b>		<b>24.05</b>	
20	CS0	1.37	0	27.55	0	20.11	0
	CS1	1.44	5.11	27.06	-1.78	18.79	-6.56
	CS2	1.57	14.60	26.23	-4.79	16.71	-16.91
	CS3	1.66	21.17	24.85	-9.80	14.97	-25.56
Mean		<b>1.51</b>		<b>26.42</b>		<b>19.64</b>	
40	CS0	1.50	0	25.65	0	17.10	0
	CS1	1.58	5.33	25.03	-2.42	15.84	-7.37
	CS2	1.62	8.00	24.62	-4.02	15.20	-11.11
	CS3	1.73	15.33	23.27	-9.28	13.45	-21.35
Mean		<b>1.61</b>		<b>24.64</b>		<b>15.40</b>	
60	CS0	1.60	0	24.74	0	15.46	0
	CS1	1.67	4.37	24.10	-2.59	14.43	-6.66
	CS2	1.75	9.37	23.26	-5.98	13.29	-14.04
	CS3	1.81	13.13	22.33	-9.74	12.34	-20.18
Mean		<b>1.71</b>		<b>23.61</b>		<b>13.88</b>	
Mean	CS0	<b>1.42</b>	<b>0</b>	<b>26.67</b>	<b>0</b>	<b>19.16</b>	<b>0</b>
	CS1	<b>1.47</b>	<b>3.52</b>	<b>26.20</b>	<b>-1.78</b>	<b>18.32</b>	<b>-4.35</b>
	CS2	<b>1.53</b>	<b>7.75</b>	<b>25.62</b>	<b>-3.96</b>	<b>17.31</b>	<b>-9.66</b>
	CS3	<b>1.59</b>	<b>11.97</b>	<b>24.63</b>	<b>-7.67</b>	<b>16.19</b>	<b>-15.5</b>

CS0 = compost without sulphur, CS1= compost with 1% sulphur, CS2 = compost with 2 % sulphur, CS3 = compost with 3 % sulphur

**- C/N ratio**

C/N ratio is considered the main important aspect of composting. Since the microorganisms involves required carbon for growth and energy and nitrogen for protein synthesis. The rate of decomposition is affected by C/N ratio. Rapid and efficient composting is achieved by C/N ratio between 25.0 and 35.0, lower ratio result in loss of N as ammonium, while higher ratio can lead to large composting period (Stevenson, 1994).

Regarding the result of C/N ratio and their relative change "RC" (%) affected by composting period and elemental sulphur additives individually or in together, the data in Table (2) show, C/N ratio of the composted organic materials were decreased with the increase of both composting period and added S. thus, the lower C/N ratio was found at the end of composting period (60 day) in the organic materials treated by 3% S. Consequently, its RC % was negative. This may be ascribed to that, the C/N ratio tended to be narrow with time in composting heaps due to gaseous loss of carbon as CO<sub>2</sub> while the nitrogen remained more highly bounded in organic combination. These findings also are in agreement with these obtained by Abd El-Wahab (1999); Ali *et al.* (2005); Aiad (2010) and Nasser (2007).

**Available macro nutrients contents**

**A - Available nitrogen**

The present data in Table (3) reveal an increase of compost content (mg/kg) of available N with prolonging the composting period and S additives individually or together. The content of available N in the compost untreated with S increased from 142 mg/kg at zero time of CP to 888 mg/kg at 60 days of CP. Also, this content after 40 day of CP was increased from 650 mg/kg in the treatment free from S to 802 mg/kg in the composted organic materials treated by 3 % S. So, all RC (%) values of compost

content of available N affected by CP and S additives were positive and become more positive in the combined treatments of them. This augmentation in the content of available N may be attributed to decomposition of organic materials, urea addition and biological fixation by compost microorganisms.

Abd El-Wahab and Ahmed (2003) found that, the relative high values of available - N obtained may be considered as an indication for occurrence the reduction in nitrogen lost during the composting stages which caused by volatilization of ammonium and leaching down of ammonium and nitrate. The factors which led to nitrogen losses are the high temperature, alkaline pH and forced action.

**B - Available phosphorus**

Regarding to the data of effect the CP (day) and S additives (%) individually or together on the composted organic materials content of available P as listed in Table (3) may be revealed that exceeding composting period and added S resulted in an increase of organic materials content of available P. For example, at the compost untreated with S the content of available P was increased from 675 mg/kg at zero time of CP to 711 mg/kg at the end CP. Also this content of compost at 40 days of CP was increased from 706 mg/kg in the compost free from S to 747 mg/kg in the compost organic materials treated by 3% S. In addition, all RC (%) values of compost content of available P as affected by CP and S additives were positive and there were more positive in the combination treatments of CP and S.

The linearly increase of available P during composting period may be attributed to the effect on phosphate dissolving microorganisms in compost mineralization, consequently releasing phosphorus in the available form. These results are in harmony with those of Singh and Sharman (2002) and Aiad (2010).

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**Table (3): Effect of sulphur additives and composting period “CP” (day) on the compost content (mg/kg) of available N, P and K and its RC % as affected by sulphur additives**

composting period (day)	Treatment of sulphur	N		P		K	
		mg kg <sup>-1</sup>	RC	mg kg <sup>-1</sup>	RC	mg kg <sup>-1</sup>	RC
0	CS0	142	0	675	0	1550	0
	CS1	145	2.11	687	1.78	1596	2.97
	CS2	148	4.23	701	3.85	1644	6.06
	CS3	150	5.63	697	3.26	1688	8.90
Mean		<b>146</b>		<b>690</b>		<b>1620</b>	
20	CS0	370	0	701	0	1647	0
	CS1	410	10.81	716	2.14	1819	10.44
	CS2	425	14.86	742	5.85	1819	10.44
	CS3	435	17.57	725	3.42	2090	26.90
Mean		<b>410</b>		<b>721</b>		<b>1844</b>	
40	CS0	650	0	706	0	1868	0
	CS1	710	9.23	725	2.69	2016	7.92
	CS2	750	15.38	756	7.08	2114	13.17
	CS3	802	23.38	747	5.81	2188	17.13
Mean		<b>728</b>		<b>734</b>		<b>2047</b>	
60	CS0	888	0	711	0	2016	0
	CS1	905	1.91	739	3.94	2041	1.24
	CS2	945	6.42	827	16.32	2114	4.86
	CS3	1003	12.95	797	12.10	2262	12.20
Mean		<b>935.25</b>		<b>768</b>		<b>2108</b>	
Mean	CS0	<b>512.50</b>	<b>0</b>	<b>698.25</b>	<b>0</b>	<b>1770.25</b>	<b>0</b>
	CS1	<b>542.50</b>	<b>5.85</b>	<b>716.75</b>	<b>2.65</b>	<b>1868.00</b>	<b>5.52</b>
	CS2	<b>567.00</b>	<b>10.63</b>	<b>756.50</b>	<b>8.34</b>	<b>1922.75</b>	<b>8.61</b>
	CS3	<b>597.50</b>	<b>16.59</b>	<b>741.50</b>	<b>6.19</b>	<b>2057.00</b>	<b>16.20</b>

CS0 = compost without sulphur, CS1= compost with 1% sulphur, CS2 = compost with 2 % sulphur, CS3 = compost with 3 % sulphur

### **C - Available potassium**

Both the content of available K and its RC (%) in the composted maize stalk as affected by composting period (day) and S in Table (3) denoted that, there are a positive relationship between composted organic materials content of available K and its RC values with either of CP or added S alone and in together. wherever the content of

available K was increased by 30.06 % compared to the control at 60 day of CP Also this content at 40 days of CP increased by 17.13 % in comparison to the control. The increase in the available K may be attributed to the mineralization process along the period of incubation Similar results were repelled by Singh and Sharman (2002); Kenawy (2003) and Taha (2007).

**D - Available calcium**

The composted maize stalk content (mg/kg) of available Ca and its relative change (RC %) at different composting periods (day) and also as affected by elemental S additives which recorded in Table (4) elucidate that, extending CP induced a slight increase in Ca availability of

the produced compost however the increase of added S resulted in a decrease of the compost content of available Ca. wherever the produced compost content of available Ca increased by 3.12 % at 60 days. however, a slight inhibition in available Ca was induced with S additives.

**Table (4): Effect of sulphur additives and composting period “CP” (day) on the compost content (mg/kg) of available Ca, Mg and S and its RC % as affected by sulphur additives**

composting period (day)	Treatment of sulphur	Ca		Mg		S	
		mg kg <sup>-1</sup>	RC	mg kg <sup>-1</sup>	RC	mg kg <sup>-1</sup>	RC
0	CS0	673	0	4449	0	152	0
	CS1	670	-0.45	4333	-2.61	8927	5773
	CS2	660	-1.93	4260	-4.25	17720	11558
	CS3	611	-9.21	4150	-6.72	27780	18176
Mean		<b>653.5</b>		<b>4431</b>		<b>4430.5</b>	
20	CS0	682	0	5143	0	185	0
	CS1	682	0.00	4726	-8.11	9970	5289
	CS2	675	-1.03	4002	-22.19	19890	10651
	CS3	619	-9.24	3851	-25.12	28850	15495
Mean		<b>664.50</b>		<b>4430.50</b>		<b>14724</b>	
40	CS0	694	0	5428	0	253	0
	CS1	692	-0.29	4749	-12.51	10760	4153
	CS2	684	-1.44	4743	-12.62	20360	7947
	CS3	658	-5.19	4527	-16.60	29250	11461
Mean		<b>682.00</b>		<b>4861.75</b>		<b>15156</b>	
60	CS0	694	0	5913	0	296	0
	CS1	694	0.00	5245	-11.30	10980	3609
	CS2	693	-0.14	4792	-18.96	20740	6907
	CS3	649	-6.48	4731	-19.99	29910	10005
Mean		<b>682.50</b>		<b>5170.25</b>		<b>15482</b>	
Mean	CS0	<b>685.75</b>	<b>0</b>	<b>5233</b>	<b>0</b>	<b>222</b>	<b>0</b>
	CS1	<b>684.50</b>	<b>-0.18</b>	<b>4763</b>	<b>-9</b>	<b>10159</b>	<b>4487</b>
	CS2	<b>678.00</b>	<b>-1.13</b>	<b>4449</b>	<b>-15</b>	<b>19678</b>	<b>8784</b>
	CS3	<b>634.25</b>	<b>-7.51</b>	<b>4315</b>	<b>-18</b>	<b>28948</b>	<b>12969</b>

CS0 = compost without sulphur, CS1= compost with 1% sulphur, CS2 = compost with 2 % sulphur, CS3 = compost with 3 % sulphur

### **E- Available magnesium**

The present data in Table (4) pointed out that available Mg appeared the same trend of Ca as affected by CP and S additives. wherever it enhanced by 32.91 % at the end of composting period in compared with control. So, on the contrary S additives showed a harmful effect on Mg availability. The high content of available Mg was found in the composted organic materials untreated by S at the end of CP. In this respect similar results were obtained by Taha (2007).

### **F- Available sulphur**

The content (mg/kg) of available S and its RC (%) values of composted maize stalk in relation with both CP and added S alone or together recorded in Table (4) showed that, increasing both CP and added augment the composted organic materials content of available S where S content increased by 94.74 % at 60 day of compost compared with the control (zero time).

Also S content after 40 days of composting period was increased by 11461 % at 3 % S additives. This attributed to the higher amount of added sulphur to the compost material. In this respect Gu *et al.* (2011) obtained on similar results.

### **- Available micronutrients content**

Both the content (mg/kg) of available micronutrients (Fe, Zn, Mn and Cu) and its relative change (RC %) affected by composting period "CP" (day) and elemental sulphur (S) additives in the composted maize stalks were recorded in Table (5). These data display that, the content (mg/kg) of available determined micronutrients were increased clearly with the increase of both CP and added S individually or together, but

these increases were become higher in combination treatments. Also, all RC values calculated for the content of available micronutrients in the composted organic materials affected by the studied treatments were positive and appeared high value at the end of CP with high rate of added S (3%). The composted organic materials contents of Fe, Zn, Mn and Cu in treatments free from S were increased from 296, 52, 318 and 13 mg/kg at zero time of CP to 403, 61, 518 and 17 mg/kg at the end of CP (60 day), respectively, Also these contents of the same determined micronutrients in the composted organic materials at 40 days of CP were increased from 367, 56, 424 and 16 mg/kg at zero treatment of elemental S to 642, 74, 550 and 25 mg/kg in the composted organic materials treated by 3% S, respectively. These data also denoted that, according to the composted organic materials content of available micronutrients under study at different CP and added levels of elemental S as individual or in combination takes the order of Mn > Fe > Cu > Zn. On the other hand, the found RC (%) values in relation with the content of these available micronutrients were widely varied from nutrient to another and also from the studied treatment to another. This promotion in the extracted available micronutrients induced with extending the period of incubation may be attributed to mineralization processes of the compost organic matter along the period of incubation consequently releasing the organic acids and chelating agents which cause an enhancement in the available micronutrients (Aiad, 2010 and Belal, 2011). These results are in agreement with these obtained by Abd El-Wahab and Ahmed (2003).

**Table (5): Effect of sulphur additives and composting period (day) on the compost content (mg/kg) of available micronutrients and its relative changes “RC” (%) as affected by sulphur additives.**

Composting Period (day)	Treatment of sulphur	Fe		Zn		Mn		Cu	
		mg kg <sup>-1</sup>	RC						
0	CS0	296	0	52	0	318	0	13	0
	CS1	303	2.36	54	3.85	318	0.00	14	7.69
	CS2	309	4.39	55	5.77	320	0.63	15	15.38
	CS3	312	5.41	55	5.77	321	0.94	15	15.38
Mean		<b>305</b>		<b>54</b>		<b>319</b>		<b>14</b>	
20	CS0	333	0	53	0	437	0	15	0
	CS1	349	4.80	57	9.62	454	3.89	17	13.33
	CS2	407	22.22	65	25.00	455	4.12	23	53.33
	CS3	591	77.48	70	34.62	488	11.67	24	60.00
Mean		<b>420.00</b>		<b>61.00</b>		<b>458.50</b>		<b>19.75</b>	
40	CS0	367	0	56	0	424	0	16	0
	CS1	460	25.34	67	19.64	512	20.75	20	25.00
	CS2	556	51.50	69	23.21	516	21.70	24	50.00
	CS3	642	74.93	74	32.14	550	29.72	25	56.25
Mean		<b>506.25</b>		<b>66.50</b>		<b>500.5</b>		<b>21.25</b>	
60	CS0	403	0	61	0	518	0	17	0
	CS1	508	26.05	66	8.20	523	0.97	20	17.65
	CS2	650	61.29	69	13.11	529	2.12	26	52.94
	CS3	811	101.24	72	18.03	618	19.31	28	64.71
Mean		<b>593.00</b>		<b>67.00</b>		<b>547.00</b>		<b>22.75</b>	
Mean	CS0	<b>350</b>	<b>0</b>	<b>56</b>	<b>0</b>	<b>424</b>	<b>0</b>	<b>15</b>	<b>0</b>
	CS1	<b>405</b>	<b>15.80</b>	<b>61</b>	<b>10.41</b>	<b>452</b>	<b>6.48</b>	<b>18</b>	<b>16.39</b>
	CS2	<b>481</b>	<b>37.38</b>	<b>65</b>	<b>16.74</b>	<b>455</b>	<b>7.25</b>	<b>22</b>	<b>44.26</b>
	CS3	<b>589</b>	<b>68.41</b>	<b>68</b>	<b>22.62</b>	<b>494</b>	<b>16.50</b>	<b>23</b>	<b>50.82</b>

CS0 = compost without sulphur, CS1= compost with 1% sulphur, CS2 = compost with 2 % sulphur, CS3 = compost with 3 % sulphur

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**تأثير إضافات الكبريت على التركيب الكيميائي للكمبوست**

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**الملخص العربى**

أجري هذا البحث فى صوبة قسم علوم الاراضى - كلية الزراعة - جامعة المنوفية - شبين الكوم - مصر لدراسة تأثير الاضافات المختلفة من الكبريت على خواص الكمبوست الكيميائية ومحتواه من المغذيات الكبرى والصغرى الميسرة عند فترات كمر مختلفة. تم تجهيز أربع كومبات من خليط من حطب الذرة الناعم والسماذ البلدى بنسبة خلط 65 : 35 % على أساس الوزن الجاف كما أضيف إلى الكومات منشطات كيميائية أخرى وقد تم ترطيب الكومات عند محتوى رطوبى 60 % من السعة التشبعية للمواد المكوره وقد أجريت عملية التهوية لهذه الكومات كل خمسة عشر يوماً. وقد أخذت عينات من كل كومة بعد صفر و 20 و 40 و 60 يوم من الكمر وقدر لها الخواص الكيميائية وكذلك محتواها من المغذيات الكبرى والصغرى الميسرة.

أوضحت النتائج المتحصل عليها أن هناك إنخفاض فى محتوى الكمبوست (%) من المادة العضوية و رقم الحموضة مع زيادة المضاف من الكبريت وكذلك مع زيادة زمن الكمر بينما زاد محتوى الكمبوست من النيتروجين والتوصيل الكهربى ولذلك قلت نسب ك : ن . بالإضافة إلى ذلك فقد ازداد محتوى الكمبوست من كل من المغذيات الكبرى الميسره (نيتروجين - فسفور - بوتاسيوم - كالسيوم - مغنسيوم والكبريت) وكذلك المغذيات الصغرى (حديد - زنك - منجنيز والنحاس) بزيادة المضاف من الكبريت وزيادة فترة الكمر. وتعنى النتائج المتحصل عليها أن إضافات الكبريت إلى المواد العضوية المتخمرة تحسن من خواص وجودة الكمبوست الناتج.