Journal of Agricultural Technology 2015 Vol.11(4):1013-1032
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Soil Mulching and Foliar Anti-transpirations Effect on Soil, Growth and Nutrients Status of Young Mango Trees Cultivated in Toshka

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Zaen El-deen, E.M.A.[1], M.F. Attia , Laila, F. Haggag , Shahin, M.F.M., E. A.-E. Genaidy and Merwad M. A. (2015) Soil Mulching and Foliar Antitranspirations Effect on Soil, Growth and Nutrients Status of Young Mango Trees Cultivated in Toshka Journal of Agricultural Technology 2015 Vol. 11(3): 1013-1032

***ABSTRACT*:**This experiment was carried out through two seasons (2012 and 2013) on mango trees four years old (*Mangifera indica* var, Keitt) grafted on sucarry rootstock grown on sandy soil at Toshki Research Station, Desert Research Center, Aswan Governorate, Egypt to investigate the effect of soil mulching by plant residues and compost and monthly foliar application (from April to August) of anti-transpiration materials such as kaolin (aluminum silicate) and silicon (potassium silicate) on leaf mineral content and vegetative growth of keitt young mango trees, and some physical and chemical soil properties. In general, results indicated that, both soil mulching and anti-transpiration materials enhanced and increased growth parameters, leaf nutrient contents and some soil physical and chemical properties. Separately mulching with compost or spraying with kaolin showed significant superiority over mulching and spraying treatments. The interaction between mulching with compost + spraying with kaolin showed the highest significant effect on improving and increasing all the studied parameters of young mango trees as well as soil properties.

Key Words: Soil mulching, foliar anti-transpiration materials, kaolin, silicon, young mango trees, growth characters, leaf nutrient contents, soil physical and chemical properties.

INTRODUCTION

Mango trees are one of the most important fruit trees, which succeed under upper Egypt conditions but high temperature degree increases evapotranspiration rate. Consequently, the amount of needed water by trees increases, especially at new reclaimed area of low water supply. Due to high temperatures of Egyptian region between (April and October) there exists very high water evaporation rate. Surface mulch (Mulch refers to a material placed on the soil surface) has a significant effect on reducing evaporation of water;

therefore, it can decrease salt accumulation as well **(Al-Rawahy *etal*., 2011)**. Many materials have been used as mulch, such as plastic film, crop residue, straw, paper pellets, gravel-sand, rock fragment, volcanic ash, poultry and live-stock litters, city rubbish, etc **(Yan-min *etal.*, 2006)**. Grass mulch is more useful in cultivation of Nagpur mandarin orchards **(Gaikwad 2004)**. Soil mulch with Egyptian clover (Trifolium alexandrinum L.) or with weed residues gave the best vegetative growth and fruit quality of 7-year-old Valencia orange trees (Citrus sinensis) under Toshka conditions **(Abdel-Aziz *etal* 2010)**. Mulching by black polyethylene (B.B.E.) and dry cut grass increased the percentage of soil moisture and the effect was pronounced by black P.E. treatment due to reducing evaporation water from soil surface. Moreover, caused significant increase in shoot length and diameter, leaf area, leaf dry and specific weights, trunk cross section area as well as average number and fresh weight of fibrous roots were proportionally increased of 7-years old "Anna" apple trees budded on Malus rootstock grown in loamy sand soil at El-Bostan region, El-Beheira Governorate **(Mikhael, 2007)**

Plants are prodigal in the water use because only roughly 5% of water uptake is used for its growth and development while the remaining 95% is lost for transpiration **(Prakash and Ramachandran, 2000).** Actively growing plants would transpire a weight of water equal to their leaf fresh weight each hour under conditions of arid and semi-arid regions if water is supplied adequately **(Moftah 1997).** Under subtropical conditions like Egypt, using antitranspirations may reduce transpiration rate from the plant; consequently the amount of used water and improved the water use efficiency **(Makus, 1997 and Singh *et al*, 1999)**. Water use is the water that is incorporated in plant tissue evaporated by the plants and soil and is controlled by the environment, plant and soil factors. Evapotranspiration (ET.) is defined as the combined processes by which water is transferred from soil surface to the atmosphere, including evapotranspiration of liquid or solid water from soil and plant surfaces, plus transpiration of liquid water through plant tissues **(Doorenbos *et al* 1979).**

In addition, a reflective Kaolin spray was found to decrease leaf temperature by increasing leaf reflectance and to reduce transpiration rate more than photosynthesis in many plant species grown at high solar radiation levels **(Nakano and Uehara 1996).** Antitranspirations (folicote and vapor-guard) increased growth parameters of Egyptian Sulani fig tree (Ficus carica) grown under rainfall conditions of the western coastal zone Matrouh Governorate. **(Al-Desouki *etal* 2009).** Spraying magnesium carbonate (Silicon) at 5% as antitranspiration and irrigate banana plants at 60% of the available water depletion is the promising treatment to reduce the total amount of irrigated water through the growing season of Williams banana plants. Besides, increased growth parameters and improved yield weight and fruit characteristics**. (Abd El-Kader *etal* 2006).** Early studies demonstrated that the reflective Kaolin improved the water status and the yield of water-stressed tomato plants, while it did not reduce carbon assimilation **(Glenn *etal*. 2003).**

Silicon, the second most abundant element in the earth's crust, has not yet received the title of essential nutrient for higher plants, as its role in plant biology is poorly understood (**Epstein, 1999**). However, various studies have demonstrated that Si application increased plant growth significantly (**Alvarez and Datnoff, 2001)**. Silicon is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, erectness of leaves and structure of xylem vessels under high transpiration rates (**Melo *et al.*, 2003; Hattori *et al*., 2005). Gong *et al*. (2003)**. Silicon application is reported to enhance leaf water potential under water stress conditions (**Matoh *et al.*, 1991)**. Magnesium silicate solution gave the highest values of N% and P% in contrast to K_2SiO_4 which gave the highest K% values in faba bean plant tissue. **(Abou-Baker *et al*, 2011)**.

The present study was outlined to study the effect of soil mulching by compost and plant residues on reducing the evapotraspiration in addition to the effect of spraying mango trees by ant transpiration such as kaolin (aluminum silicate) and Silicon (potassium silicate) on reducing transpiration and their effect on growth and nutrients status of soil and mango trees under Toshki conditions.

MATERIALS AND METHODS

The present investigation was carried out in two successive seasons i.e., 2012 and 2013 on four years old mango trees keitt cultivar grafted on sucarry rootstock and planted at 2.5×4m on sandy soil (Table 1) at Toshki Research Station, Desert Research Center Aswan Governorate, Egypt.

Table 1: Soil particles distribution and texture of the experiment soil

Depths (cm)	Coarse sand%	Fine sand%	Silt%	Clay%	Texture
0-30	71.94	21.15	6.05	0.86	Sand
30-60	70.23	22.27	6.67	0.83	Sand

The aim of this study is to investigate the effect of soil mulching by (compost and plant residues) and monthly foliar application of antitranspirations on leaf mineral content, vegetative growth of keitt mango trees and some soil physical and chemical properties. Chemical analysis of compost using in mulching was shown in Table 2.

Table 2: Chemical analysis of used compost for soil mulching.

pH	C/N Ratio	C	N	P	K	Fe	Mn	Zn
		Total %				Total ppm		
7.41	19.25	31	1.61	0.15	0.31	1241	126.3	19.8

All tested trees were healthy, nearly uniform vigor and irrigated by drip irrigation system. The recommended doses from organic fertilizers were applied at the first week of December yearly. Chemical fertilizers were applied as a fertigation doses.

The Experiment was designed as a split plot design. Soil mulching was assigned in the main plot with three treatments (without – plant residues – compost). While, antitranspirations foliar application was assigned in the sub-plot with three treatments i.e. (without – Aluminum silicate (kaolin) – potassium silicate (silicon)). Each treatment replicated thrice with two trees in each replicate.

Soil mulching treatments were carried out at the beginning of each season (in December) under the trees canopy by thickness of 5cm. All antitranspirations materials were sprayed at a concentration of 6% once monthly from April to August.

At the end of August the parameters of vegetative growth i.e. shoot length, no. of leaves per shoot, leaf fresh and dry weight, leaf area and leaf total chlorophyll content were measured. Leaves samples were collected from tested trees in September. Total leaf macronutrients content i.e. N, P, K, Ca and Mg were determined according to **Jackson (1973) and A.O.A.C. (1995)**. Total leaf micronutrients content i.e. Fe, Zn and Mn were determined according to **Wild *et al* (1985)**. Soil samples were collected pre-investigation and at the end of each season, soil samples from surface (0-30cm) and subsurface (30-60cm) layers were air-dried, ground, passed through 2mm sieve and preserved in plastic bottles for analysis. Related soil physical and chemical properties i.e. moisture constants (i.e. field capacity, wilting point and available water), total content of organic carbon, pH of soil paste extraction, soil available N (2MKCl), P and K were determined according to **Page *et al* (1984) and Klute (1986).**

The obtained data in both seasons were subjected to analysis of variance according to **Sendecor and Cochran (1986)**. Differences between means of treatments were compared using LSD0.05 Test.

RESULTS AND DISCUSSIONS

1-Vegetative growth:

1-1 Effect of soil mulching on vegetative growth:

Mulching with plant residues or compost were significantly different in relation to their effect on the different growth characters either with each other or with no mulching (Tables 3 & 4).Mulching with compost showed the highest values for shoot length (11.8cm and 12.00cm), leaf total chlorophyll content (34.95 and 34.02), total leaf area (32.01 and 32.87cm^2), leaf fresh weight (0.84 and 0.85 g), leaf dry weight (0.36 and 0.37g) and leaf moisture weight (0.48 and 0.47 g) in (2011 and 2012) respectively but the highest No. of leaves per shoot (11.3 leaves/shoot) was obtained from mulching with compost in the first season and from mulching with plant residues in the second season while the lowest values accompanied no mulching.It is worth mention that no significant difference between either mulching with plant residues and no mulching concerning leaf dry weight or mulching with plant residues and compost respecting No. of leaves per shoot in both seasons.The results were in agreements with those obtained by **Gaikwad (2004)** on Nagpur mandarin, **Abdel-Aziz *et al*. (2010)** on Valencia orange trees under Toshka conditions and **Mikhael (2007)** on "Anna" apple trees grown in loamy sand soil at El-Bostan region, El-Beheira Governorate.

In this concern, **Watson (1988) and Iles and Dosmann (1999)** stated that increased plant growth in response to mulching has been attributed primarily to conservation of soil moisture, moderation of soil temperature, and reduced competition with turf and other plants.

Table 3: Effect of soil mulching and spraying of antitranspirations on shoot length (cm), total chlorophyll and leaf area (cm^2) of keitte young mango trees

Growth Characters	Antitranspirant (A) / Mulching (M)	No spray	Kaolin	Silicon	Mean	No spray	Kaolin	Silicon	Mean
		2012				2013			
Shoot length (cm)	No mulching	7.80	9.90	10.70	9.44	8.23	9.90	10.53	9.56
	Plant residues	8.20	12.50	11.20	10.61	8.07	12.47	11.47	10.67
	Compost	8.50	14.50	12.50	11.83	8.73	14.07	13.20	12.00
	Mean	8.14	12.31	11.44		8.34	12.14	11.73	
LSD0.05		A=0.74 M=0.74 A*M=1.05				A=0.56 M=0.56 A*M=0.79			
Total Chlorophyll content	No mulching	25.36	27.87	26.60	26.61	25.60	27.80	26.90	26.78
	Plant residues	26.33	30.37	29.20	28.63	26.10	29.70	28.80	28.20
	Compost	29.37	38.17	37.30	34.95	29.60	35.70	36.70	34.02

(SPAD reading)	**Mean**	27.02	32.14	31.03		27.11	31.08	30.81	
LSD0.05		A=1.62 M=1.62 A*M=1.83				A=1.21 M=1.21 A*M=1.40			
Leaf area (cm^2)	**No mulching**	22.56	25.65	23.93	24.05	23.00	25.73	24.20	24.31
	Plant residues	28.89	29.87	28.35	29.04	28.83	31.10	28.83	29.59
	Compost	29.68	33.88	32.46	32.01	31.20	34.87	32.53	32.87
	Mean	27.04	29.80	28.25		27.68	30.57	28.52	
LSD0.05		A=1.29 M=1.29 A*M=2.09				A=0.97 M=0.97 A*M=1.78			

Table 4: Effect of soil mulching and spraying of antitranspirations on number of leaves per shoot, leaf fresh weight, leaf dry weight and leaf moisture of keitte mango trees.

Growth characters	**Antitranspirant (A) / Mulching (M)**	**No spray**	**Kaolin**	**Silicon**	**Mean**	**No spray**	**Kaolin**	**Silicon**	**Mean**
		2012				**2013**			
Number of leaves per shoot	**No mulching**	8.3	9.6	9.1	9.0	8.5	9.9	9.1	9.2
	Plant residues	8.8	13.2	11.6	11.2	9.2	12.8	11.8	11.3
	Compost	8.8	13.3	11.7	11.3	9.0	12.9	11.6	11.2
	Mean	8.6	12.0	10.8		8.9	11.8	10.9	
LSD0.05		A=0.71	M=0.71	A*M=0.82		A=0.56	M=0.56	A*M=0.64	
Leaf fresh weight (g)	**No mulching**	0.531	0.674	0.647	0.617	0.554	0.670	0.657	0.627
	Plant residues	0.620	0.833	0.724	0.726	0.610	0.814	0.744	0.723
	Compost	0.698	0.980	0.833	0.837	0.724	0.951	0.859	0.845
	Mean	0.616	0.829	0.735		0.630	0.812	0.753	
LSD0.05		A=0.029	M=0.029	A*M=0.049		A=0.023	M=0.023	A*M=0.027	
Leaf dry weight (g)	**No mulching**	0.236	0.258	0.262	0.252	0.239	0.257	0.247	0.247
	Plant residues	0.242	0.287	0.322	0.284	0.250	0.310	0.340	0.300
	Compost	0.304	0.442	0.320	0.356	0.310	0.477	0.323	0.370
	Mean	0.261	0.329	0.301		0.266	0.348	0.303	
LSD0.05		A=0.034	M=0.034	A*M=0.042		A=0.042	M=0.042	A*M=0.056	
Leaf moisture content (g)	**No mulching**	0.30	0.42	0.38	0.37	0.32	0.41	0.41	0.38
	Plant residues	0.38	0.55	0.40	0.44	0.36	0.50	0.40	0.42
	Compost	0.39	0.54	0.51	0.48	0.41	0.47	0.54	0.47
	Mean	0.36	0.50	0.43		0.36	0.46	0.45	
LSD0.05		M=0.027	A=0.027	A*M=0.050		A=0.031	M=0.031	A*M=0.042	

1-2. Effect of antitranspirations spraying on vegetative growth:

Results in Tables 3 and 4 indicated that although, the highest values of shoot length (12.31 and 12.14cm), total chlorophyll content in leaf (32.1 and

31.08), leaf area (29.80 and 30.57cm^2), no. of leaves per shoot (12.00 and 11.8) and leaf moisture content (0.50 and 0.46g) in 2011 and 2012 respectively were due to spraying with kaolin. This treatment was similar to potassium silicate spraying in respect to shoot length and total chlorophyll. However, these two types of spraying were significantly differed with the control except for leaf area where all the three treatments of antitranspirations were not significantly different.

With regard to leaf fresh weight results (Table 4) indicated that the highest value of leaf fresh weight (0.829 and 0.812g) in 2011 and 2012 seasons, respectively, was due to kaolin spraying, while the lowest one (0.616 and 0.630g) was at control. Concerning leaf dry weight; kaolin treatment had similar effect with potassium silicate spraying, but these two types of spraying were significantly higher than the control.

Generally, it could be summarized that, foliar application of antitranspirations gained superiority in plant growth characters over the control and kaolin gave the greatest plant growth vigor. The use of antitranspirations which are biodegradable organic film formulated to protect plants from injury caused by excessive transpiration or water loss through leaves, stems and branches may help in keeping healthy plant during the growing season. So, it is therefore recognized that the increments happened in vegetative growth of mango, (shoot length, leaf total chlorophyll content, leaf area, number of leaves per shoot and leaf fresh and dry weights) treated with antitranspirations such as kaolin was possibly due to two aspects. First was the protection of tissues from climatic condition, and second was the increase of water potential at a time when the growth plant was more dependants on water status than on photosynthesis (**Abou-Hadid, 1984**). The previous findings coincided with those obtained by **Al-Desouki *et al* (2009)** on Egyptian Sulani fig tree and **Abd El-Kader *et al*. (2006)** on Banana plants.

1-3. Effect of interaction between soil mulching and antitranspirations spraying on vegetative growth:

Although no significant difference was noticed at the interaction of compost mulching either with kaolin or potassium silicate spraying concerning total chlorophyll content and leaf area of young mango trees, the highest values of total chlorophyll was obtained from the trees under treatment of mulching with compost and spraying with kaolin in the first season and from the same type of mulching with potassium silicate spraying in the second season as shown in (Table 3). The highest leaf area values were obtained from mulching with compost and kaolin spraying compared with the lowest values of the control.

The highest number of leaves per shoot (13.3 and 12.9 leave/shoot) recorded in (Table 4) was due to the interaction between soil mulching with compost and spraying with kaolin in the 1^{st} and 2^{nd} seasons, respectively. This interaction had no significant difference with that between mulching with plant residues and spraying with kaolin.

The highest shoot length (14.50 cm), leaf fresh weight (0.980g) and leaf dry weight (0.443g) were shown at the interaction of compost soil mulching and kaolin spraying which was significantly surpassed all the other interactions in the first season as in (Table 3 & 4). Control (no mulching, no spraying) had the lowest values.

In relation to leaf moisture content, although , plant residues mulching with kaolin spraying showed the highest value (0.55g) in the first season as in (Table 4) but no significant difference between this treatment and mulching with compost and spraying in this respect. In addition, the lowest leaf moisture content (0.297g) was shown at no mulching with no spraying. However in the second season the highest leaf moisture content (0.54 g) was obtained from mulching with compost and potassium silicate spraying.

From abovementioned results it could be generally concluded that the interaction between soil mulching with compost and spraying with kaolin on vegetative growth characters of young mango trees surpassed significantly other interactions.

From results mentioned above, the following could be concluded: 1) adding soil mulching caused more increase in all mango vegetative growth parameters (Fig. 1) with an average 33% while spraying anti transpirations increased them by (27%) in the 1^{st} season.

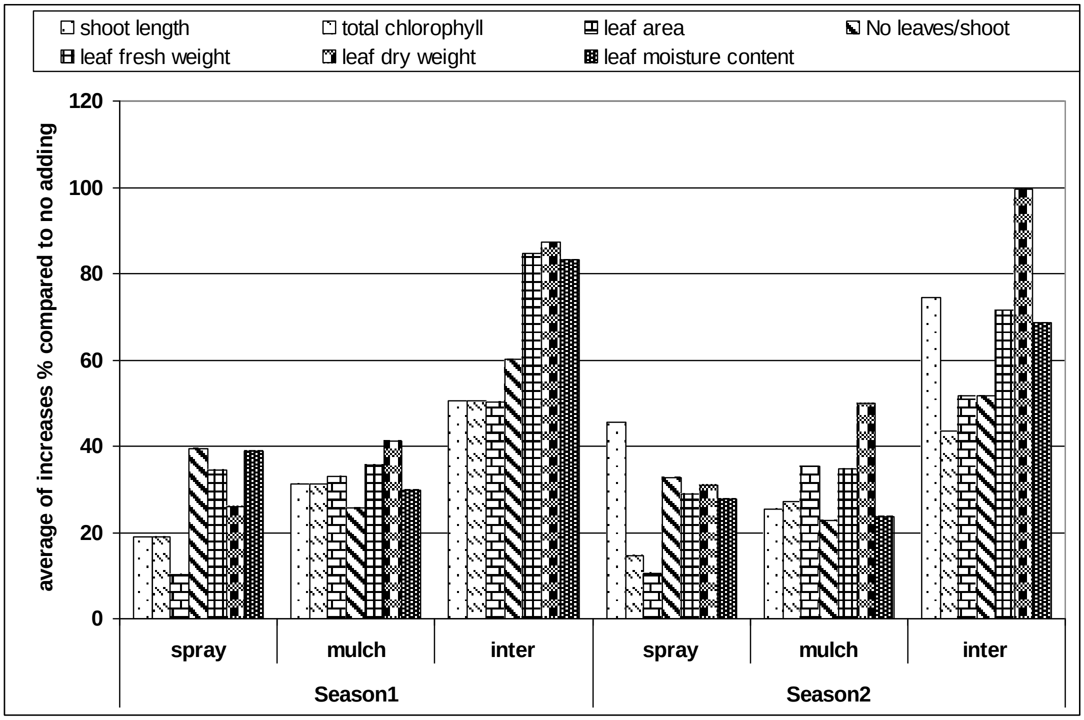

Fig. 1: Percentages increases in vegetative growth characteristics of young mango trees when comparing the highest values with the lowest ones which were noticed at control

Moreover, the interaction between mulching and spraying achieved the highest average increase (67%) for all mango vegetative growth characteristics in the 1st season. Same trend was noticed in the 2nd season. 2) From all mango vegetative growth characteristics, both leaf fresh and dry weight achieved the highest average increase each (52%) in the 1st season but in the 2nd season leaf dry weight gave the highest average increase (60%). In contrary, the lowest average increase was due leaf area (31%) in the 1st season but it was due to total chlorophyll content (28%) in the 2nd season.

2. Leaf nutrients status:

Results in Table 5 generally indicated that nutrients content in mango leaves improved significantly by adding both mulching and spraying ant-itranspiration materials either alone or in combinations in the two studied seasons.

2-1. Effect of soil mulching on leaf nutrients status:

Concerning soil mulching (Table 5), significant differences were noticed between all the treatments of mulching where compost resulted the highest values of macro (%) and micronutrients (ppm) contents in mango leaves i.e. 2.85, 0.502, 0.527, 537, 550, 81.71, 48.26 and 39.99 for N, P, K, Ca, Mg, Fe, Mn, and Zn, respectively, in the 1st season. Same trend took place in the 2nd season. These results are similar in part with those obtained by **Mikhael (2007)** who showed that soil mulching tended to increase leaf macro and micro nutrients as well as total chlorophyll contents specially in dry cut grass. **Acharya and Sharma (1994**) and **Pervaiz *et al.* (2009)** reported that mulched treatments showed significantly greater total uptake of nitrogen, phosphorus and potassium than corresponding un-mulched ones, in *Zea maize*.

Table 5: Effect of soil mulching and anti-transpiration materials on leaves nutrients contents of young mango trees .

Nutrient		Antitranspirant (A) / Mulching (M)	No spray	Kaolin	Silicon	Mean	No spray	Kaolin	Silicon	Mean
			2012				2013			
%	N	No mulch	1.57	1.88	1.42	1.62	1.63	2.02	1.90	1.85
		plant residues	2.46	2.66	2.51	2.54	2.45	2.63	2.51	2.53
		compost	2.74	2.90	2.88	2.80	2.72	2.95	2.91	2.90
		Mean	2.26	2.49	2.27		2.27	2.53	2.44	
		LSD	M= 0.089	A=0.089	A*M=0.047		M= 0.050	A= 0.050	A*M=0.017	
	P	No mulch	0.281	0.331	0.272	0.295	0.282	0.327	0.281	0.297
		Plant residues	0.403	0.435	0.424	0.420	0.395	0.435	0.421	0.417
		Compost	0.446	0.528	0.533	0.502	0.442	0.561	0.527	0.510
		Mean	0.376	0.431	0.410		0.373	0.441	0.410	
		LSD	M =0.022	A=0.022	A*M=0.016		M=0.020	A=0.020	A*M=0.013	
	K	No mulch	0.259	0.251	0.311	0.273	0.264	0.252	0.317	0.278
		Plant residues	0.393	0.434	0.435	0.421	0.393	0.429	0.435	0.419
		Compost	0.454	0.505	0.622	0.527	0.452	0.534	0.625	0.537
		Mean	0.368	0.397	0.456		0.370	0.405	0.459	
		LSD	M=0.030	A=0.030	A*M=0.011		M=0.030	A=0.030	A*M=0.015	
	Ca	No mulch	0.301	0.330	0.319	0.317	0.311	0.334	0.321	0.322
		Plant residues	0.371	0.476	0.393	0.413	0.369	0.467	0.391	0.409
		Compost	0.497	0.579	0.537	0.537	0.494	0.578	0.537	0.536
		Mean	0.390	0.462	0.416		0.391	0.460	0.416	
		LSD	M=0.0186	A=0.0186	A*M=0.0158		M=0.0168	A=0.0168	A*M=0.0138	
	Mg	No mulch	0.186	0.224	0.216	0.209	0.191	0.235	0.229	0.218
		Plant residues	0.362	0.392	0.372	0.375	0.371	0.394	0.387	0.384
		Compost	0.475	0.639	0.536	0.550	0.465	0.634	0.542	0.547

		Mean	0.341	0.418	0.375		0.342	0.421	0.386	
		LSD	M=0.0304 A=0.0304 A*M=0.0156				M=0.0306 A=0.0306 A*M=0.0151			
ppm	**Fe**	**No mulch**	66.3	71.5	69.2	69.0	68.1	75.2	73.2	72.2
		Plant residues	70.6	79.3	73.3	74.4	72.1	81.2	76.5	76.6
		Compost	75.8	86.9	82.4	81.7	77.9	87.2	85.3	83.5
		Mean	70.9	79.2	75.0		72.7	81.2	78.3	
		LSD	M=1.299 A=1.299 A*M=0.234				M= 0.806 A= 0.806 A*M=0.216			
	Mn	**No mulch**	31.4	46.2	42.7	40.1	34.5	48.6	44.1	42.4
		Plant residues	36.4	51.5	49.5	45.8	39.1	55.3	52.1	48.9
		Compost	38.4	54.2	52.1	48.3	51.3	58.1	54.3	54.6
		Mean	35.4	50.6	48.1		41.6	54.0	50.2	
		LSD	M =0.503 A =0.503 A*M=0.272				M=2.205 A=2.205 A*M=0.275			
	Zn	**No mulch**	30.4	35.3	32.2	32.7	31.2	37.4	34.1	34.2
		Plant residues	33.9	40.7	36.5	37.0	35.5	42.2	38.1	38.6
		Compost	35.6	45.1	39.2	40.0	37.1	46.9	42.9	42.3
		Mean	33.3	40.4	36.0		34.6	42.1	38.4	
		LSD	M= 0.896 A= 0.896 A*M=0.154				M=0.836 A=0.836 A*M=0.170			

In this concern **Watson (1988)** and **Iles and Dosmann (1999)** stated that the primary effects of mulches were conclusively linked to the impacts of their C:N ratio on microbial biomass and nutrient cycling as they decomposed. Clearly, understanding the dominating influence of soil microbes on nitrogen availability is a key to understanding the dynamics of soil fertility.

2-2. Effect of ant-itranspiration materials on leaf nutrients status:

Regarding to ant-itranspiration materials spraying (Table 5), significant differences were showed in the 1st season between all the treatments where the highest values of macro (in %) except K and micronutrients (in ppm) contents in mango leaves were 2.49, 0.431, 0.462, 0.418, 79.2, 50.6 and 40.4 for N, P, Ca, Mg Fe, Mn, and Zn, respectively, on kaolin spraying, whereas the highest value for K (0.456%) on silicon spraying. Similar trend was observed in the 2nd season. In this concern **Abd El-Kader *et al* (2006)** could not detect any differences between ant-itranspiration materials treatments on N, P and K content in the leaves of Banana plants. While, **Abou-Baker *et al* (2011)** reported that magnesium silicate solution gave the highest values of N% and P% in contrast to silicon which gave the highest K% values in faba bean plant tissue.

2-3. Effect of interaction between soil mulching and ant-itranspiration materials on leaf nutrients status:

In relation to the interaction effect of soil mulching and spraying antitranspirations on nutrients contents of mango leaves. Data in table 5 for the 1st season showed that the interaction of compost with kaolin surpassed significantly the other interactions and gave the highest values of all macronutrients (%) except K and all micronutrients (ppm) contents in mango leaves i.e. 2.90, 0.528, 0.579, 0.639, 86.9, 54.2 and 45.1 for N, P, Ca, Mg, Fe, Mn, and Zn, respectively. Whereas the highest value of K content (0.622, %) was due to the interaction between compost and silicon. The second season showed the same trend. These results agreed in partial with those obtained by **Moyin-Jesu (2008)**.

From the aforementioned data (Table 5), it could be concluded that adding soil mulching increased mango leaves nutrients contents with an average 67% than spraying anti transpirations (21%) in the 1st season. Moreover, the interaction between mulching and spraying achieved the highest average increase of 105% for nutrient contents in mango leaves in the 1st season (Figs. 2 & 3). Same trend was noticed in the 2nd season.

The average of increases percentages in nutrients contents of mango leaves (Figs. 2 & 3) amounted to about 83% for all macronutrients and about 32% for all micronutrients in the 1st season. The 2nd season had the same trend.

Mg content in mango leaves (Fig. 2) had the highest average increase (143%), while both P and Ca had the lowest average increase percentage (60%) in the 1st season. Similar trend was observed in the 2nd season.

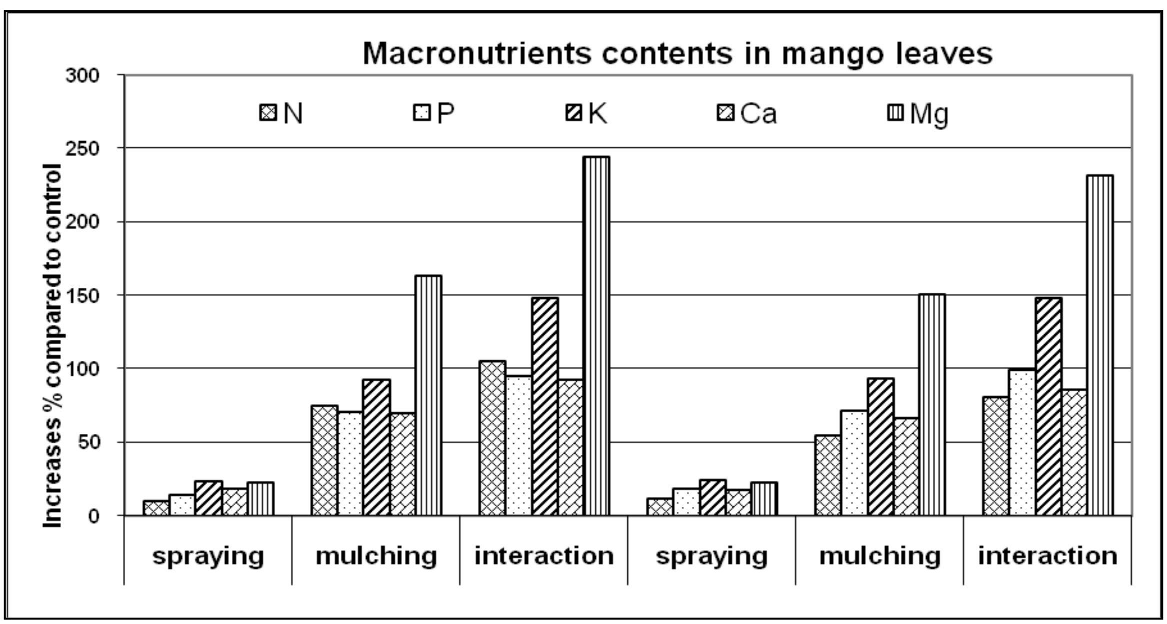

Fig. (2): Increases percentage of macronutrients contents of mango young tree by treatments over the control.

With regard to the average of increases percentages of micronutrients content in mango leaves (Fig.3), it could be concluded that Mn achieved the highest average increase (45 and 42%), whereas Fe had the lowest average increase (20 and 18%) in the 1st season and the 2nd season, respectively. Similar trend was noticed in the 2nd season.

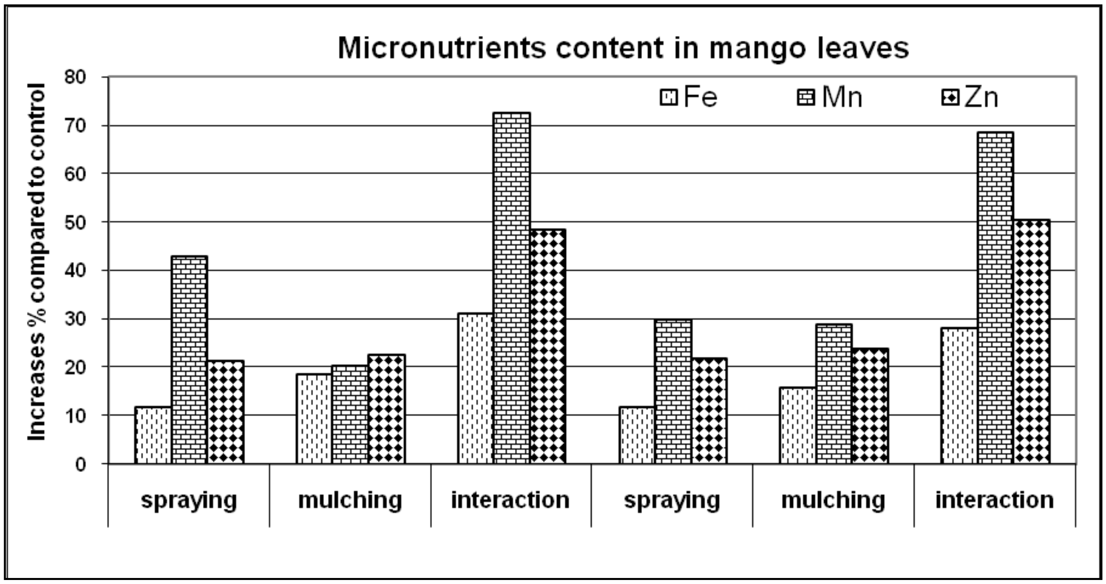

Fig. (3): Increases percentage of micronutrients contents of mango young tree by treatments over the control.

3. Moisture constants and chemical soil properties as affected by mulching, spraying and soil depth:

3.1. Soil mulching

3.1.1. Soil moisture constants:

Significant differences were found between all mulching materials treatments (Table 6) where the highest percent of field capacity (26.02%), wilting point (17.31%) and available water (8.71%) were noticed at mulching with compost. As well as the lowest values for capacity (17.61%), wilting point (11.40%) and available water (6.23%) were shown at no mulching (control). These results partially agreed with that obtained by **Liu *et al*. (2002), Khurshid**

***et al*. (2006) and Pervaiz *et al*. (2009)** who stated that mulching improved the ecological environment of the soil and increased soil water contents.

Table 6: Soil physical and chemical analysis as affected by mulching, anti transpirations and soil depths

Antitrans (A)	Without		Kaolin		Silicon		Mean	Without		Kaolin		Silicon		Mean
Depths (D) (cm)	0-30	30-60	0-30	30-60	0-30	30-60		0-30	30-60	0-30	30-60	0-30	30-60	
Mulching (M)	Field Capacity (FC) %							Wilting Point (WP) %						
Without	16.71	16.50	18.31	18.07	18.28	17.76	17.61	10.4	10.4	12.0	12.0	11.9	11.7	11.4
Plant residues	23.76	23.40	25.89	25.44	24.68	24.58	24.63	16.1	16.0	17.3	16.9	16.1	16.1	16.4
Compost	25.99	25.82	26.36	26.05	25.99	25.90	26.02	17.3	17.2	17.6	17.4	17.1	17.2	17.3
Mean	22.03		23.35		22.87			14.56		15.53		15.01		
Mean depths	0-15 cm =22.89			15-30 cm =22.61				0-15 cm =15.09			15-30 cm =14.97			
$LSD_{0.05}$	M=0.30 A=0.30 D =0.25 A*M*D = 0.47							M=0.26 A =0.26 D =0.21 A*M*D =0.33						
	Available Water (AvW) %							pH						
Without	6.33	6.11	6.33	6.11	6.41	6.11	6.23	8.14	8.03	7.81	7.79	7.83	7.80	7.90
Plant residues	7.67	7.44	8.58	8.54	8.57	8.50	8.22	7.73	7.69	7.42	7.41	7.62	7.60	7.58
Compost	8.66	8.62	8.77	8.69	8.85	8.69	8.71	7.39	7.36	7.31	7.34	7.36	7.35	7.35
Mean	7.47		7.84		7.85			7.70		7.51		7.59		
Mean depths	0-15cm=7.80			15-30 cm =7.64				0-15 cm =7.62			15-30 cm =7.60			
$LSD_{0.05}$	M =0.17 A =0.17 D =0.14 A*M*D =0.16							M =0.12 A =0.12 D =0.10 A*M*D =0.03						
	Organic Matter (OM) %							Nitrogen (N)%						
Without	0.26	0.20	0.27	0.21	0.27	0.23	0.24	0.21	0.23	0.24	0.24	0.22	0.23	0.22
Plant residues	1.86	0.26	1.97	0.35	1.96	0.33	1.12	0.27	0.28	0.30	0.31	0.28	0.30	0.29
Compost	1.27	0.30	2.72	0.34	2.38	0.31	1.22	0.30	0.32	0.33	0.34	0.31	0.33	0.32
Mean	0.69		0.98		0.91			0.27		0.29		0.28		
Mean depths	0-15 cm =1.44			15-30 cm =0.28				0-15 cm =0.27			15-30 cm =0.28			
$LSD_{0.05}$	M =0.33 A =0.33 D =0.269 A*M*D =0.09							M =0.003 A =0.003 D =0.003 A*M*D =0.005						
	Phosphorus (P) ppm							Potassium (K) ppm						
Without	2.50	2.38	2.63	2.55	2.51	2.48	2.51	22.3	22.3	25.3	25.2	25.0	24.8	24.2
Plant residues	2.75	2.71	2.97	2.94	2.83	2.77	2.83	27.9	27.9	31.3	31.3	28.7	28.6	29.3
Compost	3.17	3.14	3.71	3.68	3.30	3.28	3.38	53.8	53.7	55.8	55.7	54.0	53.9	54.5
Mean	2.78		3.08		2.86			34.7		37.4		35.8		
Mean depths	0-15=2.93			15-30=2.88				0-15=36.0			15-30=35.9			
$LSD_{0.05}$	M =0.06 A =0.06 D =0.05 A*M*D =0.04							M =0.60 A =0.60 D =0.49 A*M*D =1.34						

In this concern **Salisbury and Ross (1992)** pointed out that low water availability adversely affects hormonal balance, plant development and assimilate translocation.

3.1.2. Soil reaction (pH):

Significant differences were observed between all mulching materials treatments regarding their effect on soil pH (Table 6), where the lowest soil pH value (7.35) was shown at mulching with compost. Whereas the highest pH value (7.90) was shown at no mulching treatment.

3.1.3. Soil organic matter (OM):

The highest significant percent of OM (1.22%) were found at mulching with compost which was not different significantly with OM% at mulching with plant residues (Table 6). This may be due to the reduction in pH values which favoured the decay of the used mulching materials. These results are in accordance with those obtained by **Khurshid *et al*. (2006) and Pervaiz *et al* (2009)**

3.1.4. Soil available nutrients:

Significant differences were found between all mulching materials treatments in relation to their effect on soil available nutrients where the highest values of nitrogen (0.32%), phosphorus (3.38ppm) and potassium (54.49ppm) were shown at mulching with compost. While the lowest values of nitrogen (0.22%), phosphorus (2.51ppm) and potassium (24.2ppm) were recorded with the control. However, it was noticed that mulching with plant residues had similar effect in this regard with the compost though with lower magnitude (Table 6).

3*.2. spraying with ant-itranspiration materials:*

3.2.1. Soil moisture constants:

Spraying with kaolin showed the highest percentage for field capacity (23.35%), and wilting point (15.52%).Concerning available water, data indicated that spraying both kaolin and silicon were at par and differed significantly with the control which scored the lowest values (Table 6).

3.2.2. Soil reaction (pH) and organic matter (OM):

The lowest soil pH (7.51) was observed at spraying with kaolin (Table 6) which was not different significantly with the spraying with silicon, but different significantly with the control (no spraying). Regarding soil organic matter, from tabulated data it can be noticed that there were no significant differences among all the three spraying treatments regarding soil organic matter.

3.2.3. Soil available nutrients:

Significant differences were showed between all the three spraying treatment viewing soil available nutrients (Table 6) where the highest values for N (0.29%), phosphorus (3.08ppm) and potassium (37.42ppm) were shown at spraying with kaolin. These highest values may be due to the reduction in pH values and increasing in soil organic matter content.

3.3. Soil depths:

3.3.1. Soil moisture constants:

Results in Table 6 indicated that moisture contents in the surface soil layer (22.89%FC and 7.80%AvW) were surpassed significantly those in the sub surface soil layer (22.61% FC and 7.64% AvW). Moreover, soil moisture contents at wilting point were the same in both surface and subsurface soil layers.

3-3-2. Soil reaction (pH) and organic matter (OM):

Changes in soil reaction (pH) value in both surface and subsurface soil layers were insignificant (Table 6). Regarding, soil organic matter content in the surface soil layer (1.44%) surpassed significantly that of the sub surface soil layer (0.28%). This may be due to the effect of aeration on the decomposition of mulching materials and also other chemical reactions in the surface soil layers.

3.3.3. Available soil nutrients:

Available nitrogen content in the sub surface soil layer (0.29%) surpassed significantly that of the surface soil layer (0.27%) as shown in Table 6. On contrary, available phosphorus content in the surface layer (2.93ppm) surpassed significantly that of the sub surface soil layer (2.88ppm). Both surface and subsurface layers were not different significantly regarding their content of available potassium.

3.4. Moisture constants and chemical soil properties as affected by the interaction between mulching, spraying and soil depths:

***3.4.1. Soil moisture constants*:**

Data in Table 6 indicated that there were significant differences between most of the interaction treatments regarding their effect on soil moisture content i.e. FC, WP and AvW. The highest values i.e. 26.34%FC, 17.59%WP and 8.85%AvW were shown at interaction of mulching with compost and spraying with kaolin in the soil surface layer. Besides, it can be noticed that no significant differences were shown at the interactions of no mulching with all the treatments of anti transpirations in soil surface layer on AvW.

3-4-2. Soil reaction (pH):

Data in Table 6 indicated that there were significant differences between most of the interaction treatments regarding their effect on soil reaction (pH) where the lowest pH value (7.31) was shown at treatment of mulching with compost and spraying with kaolin in soil surface layer. Whereas, the highest pH value (8.14) was shown at treatment of no mulching and no antitranspirant in soil surface layer.

3.4.3. Organic matter (OM) and available nutrients :

Results in Table 6 showed that there were significant differences due to most of the interactions between soil mulching, anti transpirations spraying and soil depths regarding their effect on OM and available nutrients. The highest values of OM, P and K were generally noticed at soil surface layers and were due to the interaction between compost mulching and kaolin spraying, whereas the highest values of N were shown at the sub surface layer and accompanied the compost mulching with spraying kaolin.

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(received 15 February 2015;accepted 30 April 2015)