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RESPONSE OF TOMATO PLANTS GROWN UNDER RECLAIMED SOIL CONDITIONS TO FOLIAR APPLICATION OF MAGNESIUM

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ABSTRACT

The effect of magnesium foliar appliaction on tomato plants was evaluated through two field trials during the two successive growing seasons of 2007 and 2008 at a private Farm (a reclaimed soil), Fayoum, Egypt. To verify this objective, Saria and GLX hybrids of tomato were grown under reclaimed soil conditions and sprayed with magensium (Mg) at the rate of 5, 10, 15, 20 and 30 mgL^{-1} (as a chelated form).

The obtained results showed the following trends:

- Both of the two hybrids; Saria and GLX showed a different response to Mg foliar application treatments in all studied parameters (growth, yield and chemical constituents).
- The foliar application of Mg caused an increase in all the studied characters; growth, yield and quality as well as chemical composition. The response was up to the 15 mgL^{-1} level of Mg then decrease again in both seasons (except Mg concentration in leaves).
- The evaluated parameters were positively affected by the interaction between Mg levels x cvs. Saria cv. which sprayed with Mg at the rate of 15 mgL^{-1} recorded the highest values of the most vegetative growth characters; leaves dry weight $plant^{-1}$, branches dry weight $plant^{-1}$ and leaf area $plant^{-1}$ in the first and second seasons while, No. of leaves $plant^{-1}$ and canopy dry weight $plant^{-1}$ in the first season only.
- The results revealed that GLX cv. proved superior with highest mean values for fruit yield m^{-2} and fruit number m^{-2} compared with those of Saria cv. which recorded a high value in fruit weight.
- Foliar application of Mg increased (comparing to the control) total chlorophyll, carotenoids, N%, K%, P%, Mg% and Ca% in leaves and vitamin C, total acidity, TSS% in fruit of the two hybrids of tomato. The incline in the concentration of the previous mentioned chemical constituents gradually increased as Mg level was increased till 15 mgL^{-1} then decrease again (except in leaves which increased up to 30 mgL^{-1}).
- In this respect, all rates of Mg gave higher values with the hybrid of GLX in the most of chemical constituents over the corresponding Saria cv. in both seasons.
- In comparison to other Mg rates, the two hybrids showed similar trends to Mg at the rate of 15 mgL^{-1} where the highest values of all the studied parameters; growth, yield and quality as well as chemical composition (except Mg concentration in leaves) were obtained by both of Saria and GLX cvs.

Finally, the present study showed that the best level of Mg foliar application was 15 mgL^{-1} Mg which, produced the highest yield with a good quality of tomato plants grown under reclaimed soil conditions with the superiority of GLX cv. in this respect comparing with Saria cv.

Keywords: magnesium, foliar application, tomato, reclaimed soil, growth, yield quality, chemical composition.

INTRODUCTION

In Egypt, tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetable crops for local consumption and exportation. Beside the trials for improving tomato productivity in the old soils, others must be carried out to improve the growth and yield of tomato in the newly reclaimed soils. But this kind of soil showed a great deficiency in macronutrients. The efficiency of fertilizers used in Egypt is low, either as a result of high pH of soil and/or the concentration of calcium carbonate. This problem could be solved by soil addition of great amounts of macro-mineral fertilizers or through foliar application of them. Several attempts were tried on the application of micronutrients spray to correct deficiency symptoms and enhance vegetative growth which in turn reflect on increasing yield and its quality for facing local consumption and exportation (Badr *et al*., 1991; Moussa *et al*., 1996 and Sabik *et al*., 2002), but no a large attention received for the spray of macronutrients in the newly reclaimed soils. Magnesium is an important macronutrient for higher plants. Like other nutrients, Mg cation display individual functions as well as mutual interactions (Ruiz *et al*., 1999). Magnesium deficiency is most prevalent on sandy textured soils, which are subjected to leaching. A deficiency of magnesium will seriously affect plant growth and development as photosynthesis is directly affected (Marschner, 1995). Crops that commonly exhibit magnesium deficiency include tomato (Tucker, 1999). Foliar application is widely used to correct a specific nutrient deficiency to prove nutrients balance and its preferable in reclaimed soil where this soil is usually poor in their nutrients content (Amberger, 1982 and Fawzi, 1991). The positive effect of foliar application of macronutrients on growth, yield and chemical constituents of different plants may be attributed to these elements can be readily absorbed by the leaves as a result of foliar spraying application and not lost through fixation, decomposition or leaching under unfavorable soils conditions (Doeing, 1986). The production of several hybrids of tomato seeds in the recent few years increased the need for much research work on such hybrids in Egypt in order to improve yield and fruit quality under reclaimed soil conditions.

Thus, the present work is a trial to study the influence of foliar spray with magnesium on growth, yield and chemical constituents of tomato hybrids grown under reclaimed soil conditions.

MATERIALS AND METHODS

During the growing seasons of 2007 and 2008, two experiments were conducted under field conditions at a private Farm, Tamiya, Fayoum, Egypt, to study the influence of magnesium foliar applying on growth, yield and its components of tomato under reclaimed soil conditions (loamy sand soil). Before transplanting, a sample from the selected soil (0-30 cm in depth) was taken and analyzed. The physical and chemical analyses of soil were performed in both seasons according to published procedure (Wilde *et al*., 1985) and presented in Table (1).

Table (1): Physical and chemical characters of the tested soil in both seasons of 2007 and 2008.

Soil property	2007	2008
Physical:		
Sand %	67.7	69.1
Silt %	19.2	20.3
Clay %	13.1	10.6
Soil texture	**loamy sand soil**	**loamy sand soil**
pH (1:2.5)	7.65	7.47
ECe (dsm^{-1})	4.09	4.73
Organic matter%	0.71	0.68
$CaCO_3$%	13.13	12.68
Soluble ions (mg 100^{-1} g soil):		
CO_3^{--}	-	-
HCO_3^-	4.19	5.01
Cl^-	1.60	1.76
Ca^{++}	15.41	17.44
Mg^{++}	10.23	11.72
Na^+	12.76	13.85
K^+	0.76	0.82
SO_4^{--}	1.93	1.26
Total elements:		
N%	0.22	0.20
Fe%	3.04	3.54
Mn (mg kg^{-1})	430.53	480.50
Zn (mg kg^{-1})	29.33	26.50
DTPA extractable micronutrients (mg kg^{-1}):		
Fe	3.09	3.29
Mn	9.10	9.81
Zn	0.11	0.09

In both seasons, the selected area was divided into small plots (10.5 m^2). All plots involved 3 rows, each of 3.5m in length and 1m in width. Seeds of the tested hybrids; Saria and GLX (Petoseed Co. USA) were seeded on March 1st in both seasons in seedling trays contained a mixture of peatmoss and vermiculite 1:1 (V/V). The mixture was enriched with macro-and micro nutrients and treated with the fungicide (Benlate 0.1%). Trays were kept in the greenhouse. Before transplanting, the seedlings were hardened for 10 days by subjecting them to the open field conditions. Tomato seedlings (30 days old) were transplanted into the field on the rows with interspaces of 50cm between plants on the 30th of March in both seasons for two hybrids. Recommended cultural practices for commercial tomato production were followed as described by the Egyptian Ministry of Agriculture.

Foliar applying treatments of Mg in each of the two seasons carried out as follow:

1- Control: untreated plants (sprayed with tap water only)
2- Spraying with 5mgL^{-1} Mg
3- Spraying with 10 mgL^{-1} Mg
4- Spraying with 15 mgL^{-1} Mg
5- Spraying with 20 mgL^{-1} Mg
6- Spraying with 30 mgL^{-1} Mg

The plants were twicely sprayed during the growing season with Mg at the previously mentioned levels for each (or with tap water for control) in the form of Li-Mg, 5.5% (EDTA). The first application (the half of dose of each treatment) was done after 21 days from transplanting and the second one (the rest half of dose) was carried out 15 days later. However, few drops of Tween-20 were added to the spraying solution as a wetting agent. Treatments in all experiments of both seasons were distributed in a split-plot in randomized complete blocks design with four replications.

Plant sampling:

After seventy days from transplanting, a random sample of ten plants from each treatment was chosen for measuring the following growth characters: No. of leaves plant^{-1}, leaf area leaf^{-1} (cm^2); the area of the fourth leaf from the apex was measured by a Planimeter (Planix tomaya a digital, model 2107) then used for estimating leaves area plant^{-1} (leaf area x No. of leaves plant^{-1}), dry weight of leaves plant^{-1} (g), dry weight of branches plant^{-1} (g) and total canopy dry weight plant^{-1}. The samples of fresh leaves and branches were dried at 70°C in a forced air–oven for 48h till a constant weight and their dry weights were recorded. The dried leaves were ground then kept for chemical analysis.

At the fruiting stage, red ripe fruits of ten plants from each treatment were randomly chosen to estimate the following parameters: average fresh fruit weight (g), number of fruits m^{-2}.

Chemical analysis:

A random sample of fresh leaves was taken after seventy days from transplanting for determination of the leaf pigments; total chlorophyll and carotenoids concentration (mg g^{-1} fresh weight of leaf). They were extracted by acetone 80% then determined using colorimetric method as described by Arnon (1949). Dry matter of leaves were used for determination of the following parameters: nitrogen% was colorimetrically determined by using the Orange G dye according to the method of Hafez and Mikkelsen (1981) and a factor of 6.25% was used for conversion of nitrogen (N%) to protein% (Kelley and Bliss, 1975). For P, K, Mg and Ca determination, the wet digestion of 0.1g of fine dry material of leaves of each treatment were done with sulphuric and perchloric acids as described by Piper (1947). Phosphorus% was colorimetrically estimated by using chlorostannous molybdophosphoric blue colour method in sulphuric acid system as described by Jackson (1967). Potassium% was determined using a Perkin-Elmer, Flame Photometer (Page *et al.*, 1982). Magnesium% and calcium% were determined using a Perkin-Elmer, Model 3300, Atomic Absorption Spectrophotometer according to the method described by Chapman and Pratt (1961). Vitamin C (mg 100^{-1} g of fresh fruits) was estimated as described by A.O.A.C. (1990). In fresh fruits, total soluble solids% (TSS%) were estimated in filtered homogenized portion of fresh fruits using a handle refractometer model PZO Nr. 19877. Total acidity (g citric acid 100^{-1}g juice) was determined as illustrated by A.O.A.C. (1990).

Statistical analysis:

In the two seasons, analysis of variance was used to assess the significance of treatment means (Snedecor and Cochran, 1980). Differences between treatment means were compared using the least significant difference (LSD) at the probability level of 0.05.

RESULTS AND DISCUSSION

Growth characters:

Data recorded in Tables (2 and 3) clearly indicate that the comparisons among the mean values of the vegetative growth of tomato hybrids; No. of leaves plant^{-1}, leaves dry weight plant^{-1}, branches dry weight plant^{-1}, leaves area plant^{-1} and canopy dry weight plant^{-1} showed a significant difference. Saria hybrid is characterized with the highest values for No. of leaves plant^{-1} (in the first season only) while, the other characters were increased in both seasons than those of GLX hybrid (except canopy dry weight plant^{-1} which recorded an increase by Saria cv. over GLX cv. in the first season and was less than of GLX cv. in the second season). Saria and GLX were not significantly different from each other in leaves area plant^{-1} in the second season as shown in Table (2). Such differences of tomato hybrids may be due to the genetically make up. The results clearly demonstrate that these is a gradual increase in the mean values of the evaluated vegetative growth traits with increasing the level of foliar application with Mg till 15mgL^{-1}(which recorded the highest values) then decreased again in both seasons. The concentration of 15 mg L^{-1} recorded an increase over than the control by 46.51%, 41.00%, 31.92%, 68.49% and 36.62% in the first season, and by 54.72%, 33.88%, 47.09%, 76.51% and 39.85% in the second season for No. of leaves plant^{-1}, leaves dry weight plant^{-1}, branches dry weight plant^{-1}, leaves area plant^{-1} and canopy dry weight plant^{-1}, respectively. However, the increases between the most concentrations of Mg and control as well as within them were significant. The interaction between hybrids and Mg levels was significant for the most tested characters of vegetative growth. The highest values were recorded with hybrid Saria sprayed with 15 mgL^{-1} Mg in both growing seasons (except the second season for No. of leaves plant^{-1}) whereas, the lowest values were recorded by hybrid GLX sprayed with 30 mgL^{-1} Mg in the two seasons (except the second season for No. of leaves plant^{-1} and branch dry weight plant^{-1}). The interaction revealed that in each of the two used hybrids, the studied growth traits increased with increasing Mg level till 15mgL^{-1} then declined again. In this respect, dry matter production of plant increased with increasing Mg rate (Mirabdulbaghi and Mitra, 1993 and Hao and Papadoulos, 2004). Thus, the results showed that the recorded growth characters react differentially to varying levels of Mg and/or the evaluated hybrids. Such increase in growth parameters may be attributed to the effect of Mg on some physical functions such as carbohydrates synthesis and active many enzymes which in turn affect plant growth (Marschner, 1995).

The positive effect of foliar application of Mg on the above mentioned growth characters of tomato may be attributed to that Mg can be readily absorbed by the leaves as a result to foliar spray and not lost through fixation, decomposition or leaching under unfavorable soil conditions. In addition, after Mg absorption, it acts as an osmotic material for cell turger metabolic activities are completely achieved. Thus, it could be concluded that Mg fertilization caused an increase in growth. This increase is mainly due to the increase growth components owing to the role of Mg (as one of the essential components entering in the structure of chlorophyll molecule responsible for photosynthesis) in the synthesis of metabolic products (Marschner, 1995).

Table (2): Effect of foliar application of magnesium on number of leaves plant^{-1}, Leaves and Branches dry weight plant^{-1} and Leaves area plant^{-1} of tomato plants in both seasons of 2007 and 2008.

Mg levels (mgL^{-1})	2007 Tomato hybrids			2008			2007 Tomato hybrids			2008		
	Saria	GLX	Mean	Saria	GLX	Mean	Saria	GLX	Mean	Saria	GLX	Mean
	No. of leaves plant^{-1}						Leaves dry weight plant^{-1}(g)					
0	45.00	51.75	**48.38**	51.50	56.75	**54.13**	25.70	24.30	**25.00**	32.05	31.40	**31.73**
5	48.00	59.75	**53.88**	58.25	68.00	**63.13**	29.20	26.05	**27.63**	34.55	33.45	**34.00**
10	55.75	68.75	**62.25**	65.50	77.50	**71.50**	34.00	28.90	**31.45**	37.95	37.65	**37.80**
15	63.25	78.50	**70.88**	76.00	91.50	**83.75**	36.70	33.80	**35.25**	42.55	42.40	**42.48**
20	51.50	59.75	**55.63**	68.00	77.75	**72.88**	26.55	24.80	**25.68**	34.25	33.30	**33.78**
30	48.75	55.70	**52.23**	65.00	73.75	**69.38**	26.35	22.75	**24.55**	32.95	30.10	**31.03**
Mean	**52.04**	**62.37**		**64.04**	**74.21**		**29.75**	**26.77**		**35.72**	**34.72**	
$LSD_{(0.05)}$												
V		**2.23**			**2.46**			**1.29**			**0.95**	
T		**4.12**			**3.89**			**1.12**			**1.25**	
VxT		**6.33**			**6.56**			**2.18**			**2.22**	
	Branches dry weight plant^{-1}(g)						Leaves area plant^{-1}(cm^2)					
0	24.42	22.20	**23.31**	28.08	24.15	**26.12**	2398	2286	**2342**	2429	2390	**2410**
5	24.78	23.79	**24.29**	31.29	29.58	**30.44**	2760	2686	**2723**	3048	2947	**2998**
10	29.73	26.73	**28.23**	38.49	34.92	**36.71**	3419	3290	**3355**	3641	3446	**3544**
15	33.30	28.20	**30.75**	40.02	36.81	**38.42**	4076	3816	**3946**	4398	4109	**4254**
20	28.53	22.38	**25.46**	31.26	31.71	**31.49**	3106	2872	**2989**	3616	3472	**3544**
30	25.65	21.69	**23.67**	28.17	28.41	**28.29**	2849	2652	**2751**	3381	3138	**3260**
Mean	**27.74**	**24.17**		**32.89**	**30.93**		**3101**	**2934**		**3419**	**3250**	
$LSD_{(0.05)}$												
V		**1.33**			**1.07**			**150**			**132**	
T		**1.05**			**1.24**			**298**			**265**	
VxT		**2.26**			**2.40**			**421**			**375**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

Yield:

Data illustrated in Table (4) show the influence of Mg foliar application and hybrids on yield and quality of tomato. The results revealed that GLX cv. proved superior with highest mean values for fruit yield m^{-2} and fruit number m^{-2} compared with those of Saria cv. in the first and second seasons. Meanwhile, a higher value of fruit weight was recorded by Saria cv. over than GLX cv. in the first and second seasons. However, the differences between the two hybrids were significant in all traits of yield. The results indicate that the application of the Mg caused a significant increase in fruit number and fruit weight which were positively reflected positively on fruit yield m^{-2} in both seasons. The response was up to the $15mgL^{-1}$ level of Mg then the decrease is existed. The level of 15mgL^{-1} recorded an increase over the control by 81.27%, 68.90% and 26.90% in the first season and by 49.40%, 34.62% and 19.45% in the second season for fruit yield m^{-2}, fruit number m^{-2} and fruit weight, respectively.

Table (3): Effect of foliar application of magnesium on canopy dry weight plant^{-1} of tomato plants in both seasons of 2007 and 2008.

Mg levels (mgL^{-1})	2007			2008		
	Tomato hybrids					
	Saria	GLX	Mean	Saria	GLX	Mean
	Canopy dry weight plant^{-1} (g)					
0	50.12	46.50	**48.31**	60.13	55.55	**57.84**
5	53.98	49.84	**51.91**	65.84	63.03	**64.44**
10	63.73	55.63	**59.68**	76.44	72.57	**74.51**
15	70.00	62.00	**66.00**	82.57	79.21	**80.89**
20	55.08	47.18	**51.13**	65.51	65.01	**65.26**
30	52.00	44.44	**48.22**	61.12	58.51	**59.32**
Mean	**57.49**	**50.93**		**68.60**	**65.65**	
LSD$_{(0.05)}$ V		**3.53**			**2.76**	
T		**4.21**			**3.46**	
VxT		**6.11**			**5.45**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

The interaction between tomato hybrids and Mg concentrations was significantly affected yield and quality. Foliar application of Mg at 15 mgL^{-1} with GLX cv. resulted in the highest value of fruit yield m^{-2} and fruit number m^{-2} over than those recorded by Saria cv. in both seasons. On the other hand, results indicate that the highest value of fruit weight was proved with Saria cv. which received 15 mgL^{-1} Mg compared with GLX cv. in both growing seasons. In this respect, a positive relationship between the fruit yield and Mg level (Elamin and Wilcox, 1985; Candilo *et al*., 1993; Hao and Papadoulos, 2004 and Haque *et al*., 2006), yield quality (Chapagain and Wiesman, 2004). This superiority in yield and quality may be attributed to the important role of Mg in increasing the activity of plant metabolism, which reflected on fruit yield and good visual properties. Thus, the results showed that the recorded yield traits react differentially to varying rates of Mg and/or the tested hybrids. The beneficial effect of Mg as a foliar fertilizer on the yield and its components of tomato plants may be due to that Mg play an important role in formation of the organic compounds such as, carbohydrates, lipids,….etc (Marschner, 1995), which translocate to the reproductive organs and consequently increasing the yield and its components.

Chemical composition:

It is evident from the data in Tables (4, 5, 6 and 7) that Mg foliar application had a positive effect on the estimated chemical compounds in leaves and fruits of tomato cvs. compared with those of the treatment having no Mg application. The results clearly show that there is a difference between the two studied hybrids (Saria and GLX) in all the estimated chemical compounds. The leaves of GLX cv. had the higher mean values in concentrations of total chlorophyll, carotenoids, N%, P%, K%, Mg% and Ca% as well as the concentration of vitamin C, total acidity, TSS% in fruit as compared with Saria cv. However, the difference reaches the level of significance between GLX and Saria cvs. in total chlorophyll, carotenoids, K%, Mg% and Ca% and did not having a level of significance in concentration of vitamin C, total acidity, TSS%, N% and P%. Increasing level of Mg significantly caused an increase in concentration of all these compounds either in leaves or in fruits as compared with the control. The level of 15 mgL^{-1} Mg had the highest mean values in this respect for both the tested hybrids in both seasons as compared with all other treatments (except Mg concentration in leaves). As compared with the control, the level of 15 mgL^{-1} Mg recorded the increases at 33.17%, 48.72%, 39.66%, 34.59%, 12.11%, 21.74%, 50.00%, 23.32%, 24.03% and 8.82% in the first season. While, in the second one the increases were 29.30%, 36.51%, 43.33%, 30.09%, 13.56%, 22.99%, 52.63%, 23.28%, 19.37% and 11.43% for total chlorophyll, carotenoids, total acidity, vitamin C, TSS%, N%, P%, K%, Ca% and Mg%, respectively. Regarding the effect of interaction of hybrids and Mg foliar application on the chemical composition of leaves and fruits of the tested hybrids, the data in Tables (4, 5, 6 and 7) indicate that GLX cv. which sprayed with Mg at the rate of 15 mgL^{-1} gave the highest values of the estimated chemical compounds in both leaves and fruits as compared with those in Saria cv. in both seasons (except the concentration of total chlorophyll in the first season only and carotenoids in both seasons). However, the concentration of Mg in leaves was linearly increased by Mg application till the highest rate in both hybrids during the two seasons. Differences between the two hybrids might be due to the genetically differences which led to the differences in plant concentration of these chemical compounds in both leaves and fruits in the two seasons. The interaction effect was mainly dominated by the genetically potential of each hybrid since the response of these differences to the same application rate of Mg.

In this manner, Mg concentration in leaf tissue linearly increased with increasing Mg level (Harrison and Bergman, 1981 and Elamin and Wilcox, 1985), markedly increased TSS% in tomato fruits (Candilo *et al*., 1993) and P concentration (Kolota and Biesiada, 1990). The chlorophyll content of leaves of tomato increased with increasing Mg rate (Hao and Papadoulos, 2004). Increasing total chlorophyll in leaves of tomato due to that Mg is considered as the central atom in the chlorophyll molecule consequently, Mg effects plant chlorophyll content in leaves (Marschner, 1995).

It is clear from the present results that the increase of chemical constituents by the increase of Mg concentration may be attributed to Mg which increases the capacity of plants to adsorb nutrients by the increase of root surface $unit^{-1}$ of soil volume as well as the high capacity of plants supplied with Mg in building metabolites which in turn contributes to the increase of nutrients uptake which are important in the activity of a large number of enzyme systems in plant which have a major role in the synthesis of photosynthates; sugars, vitamin C,….etc. In addition, the increasing activity of photosynthesis with Mg leads to a increase in total acidity in tomato fruits.

Table (4): Effect of foliar application of magnesium on fruit yield, fruit number, fruit weight and total chlorophyll of tomato plants in both seasons of 2007 and 2008.

Mg levels (mg L^{-1})	2007			2008			2007			2008		
	Tomato hybrids						Tomato hybrids					
	Saria	GLX	Mean	Saria	GLX	Mean	Saria	GLX	Mean	Saria	GLX	Mean
	Fruit yield Kg m^{-2}						Fruit number m^{-2}					
0	2.38	5.19	**3.79**	3.61	4.68	**4.15**	35.27	101.50	**68.39**	44.75	64.25	**54.50**
5	3.43	6.83	**5.13**	3.95	5.58	**4.77**	47.28	112.93	**80.11**	46.75	70.17	**58.46**
10	4.27	7.62	**5.95**	4.30	6.76	**5.53**	53.66	120.23	**86.95**	47.87	83.53	**65.70**
15	5.41	8.33	**6.87**	5.18	7.21	**6.20**	61.91	169.10	**115.51**	53.75	92.98	**73.37**
20	4.29	6.98	**5.64**	4.43	6.77	**5.60**	58.38	152.35	**105.37**	53.14	87.70	**70.42**
30	3.75	6.97	**5.36**	4.35	6.59	**5.47**	55.60	138.70	**97.15**	52.76	84.29	**68.53**
Mean	**3.92**	**6.99**		**4.30**	**6.27**		**52.02**	**132.47**		**49.84**	**80.49**	
$LSD_{(0.05)}$												
V		**0.30**			**0.25**			**3.05**			**4.05**	
T		**0.48**			**0.23**			**5.24**			**2.60**	
VxT		**0.67**			**0.33**			**7.41**			**3.67**	
	Fruit weight (g)						Total chlorophyll (mgg^{-1} fresh weight of leaf)					
0	67.79	51.16	**59.48**	80.61	72.93	**76.77**	1.96	2.14	**2.05**	2.04	2.26	**2.15**
5	73.24	55.30	**64.27**	84.54	79.59	**82.07**	2.04	2.26	**2.15**	2.10	2.36	**2.23**
10	79.83	60.44	**70.14**	89.76	81.07	**85.42**	2.41	2.39	**2.40**	2.27	2.51	**2.39**
15	87.57	63.39	**75.48**	97.80	85.59	**91.70**	2.72	2.73	**2.73**	2.76	2.79	**2.78**
20	73.66	51.82	**62.74**	82.55	77.23	**79.89**	2.56	2.69	**2.63**	2.64	2.78	**2.71**
30	67.56	50.38	**58.97**	82.41	70.96	**76.69**	2.49	2.67	**2.58**	2.56	2.62	**2.59**
Mean	**74.94**	**55.42**		**86.28**	**77.90**		**2.36**	**2.48**		**2.40**	**2.55**	
$LSD_{(0.05)}$ V		**2.83**			**5.05**			**0.15**			**0.10**	
T		**5.61**			**4.43**			**0.09**			**0.09**	
VxT		**7.94**			**6.27**			**0.12**			**0.13**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

However, the decrease in all the studied parameters (except Mg concentration in leaves) in this study over the concentration of 15mgL^{-1} may be due to that:

1. Mg is required in smaller amounts than the primary nutrients; N, P and k (Ruiz *et al*., 1999) thus, application of high concentration of Mg leads to inhibition of photophosphorylation and photosynthesis in stroma consequently, a depressing in growth and yield and visual symptoms of Mg toxicity occur when the proportional of Mg in the chlorophyll exceeds (Rao *et al*., 1987 and Marschner, 1995).

2. Photosynthesis is strongly inhibited even by the high concentration of magnesium in the external solution. This inhibition is caused by a decrease in potassium influx and corresponding acidification of the stroma upon illumination (Wu *et al*., 1991).

Table (5): Effect of foliar application of magnesium on Carotenoids, Total acidity, Vitamin C and total soluble solids (TSS%) of tomato plants in both seasons of 2007 and 2008.

Mg levels (mgL^{-1})	2007 Saria	2007 GLX	2007 Mean	2008 Saria	2008 GLX	2008 Mean	2007 Saria	2007 GLX	2007 Mean	2008 Saria	2008 GLX	2008 Mean
	Carotenoids (mg g^{-1} fresh leaf)						Total acidity (g $100g^{-1}$ juice)					
0	1.02	1.31	**1.17**	1.17	1.35	**1.26**	0.58	0.58	**0.58**	0.59	0.61	**0.60**
5	1.16	1.44	**1.30**	1.28	1.42	**1.35**	0.73	0.70	**0.72**	0.73	0.75	**0.74**
10	1.38	1.58	**1.48**	1.31	1.54	**1.43**	0.76	0.79	**0.78**	0.81	0.80	**0.81**
15	1.76	1.71	**1.74**	1.60	1.84	**1.72**	0.77	0.84	**0.81**	0.83	0.88	**0.86**
20	1.68	1.69	**1.69**	1.54	1.77	**1.66**	0.75	0.82	**0.79**	0.71	0.82	**0.77**
30	1.49	1.62	**1.56**	1.46	1.60	**1.53**	0.72	0.67	**0.70**	0.70	0.68	**0.69**
Mean	**1.42**	**1.56**		**1.39**	**1.59**		**0.72**	**0.73**		**0.73**	**0.76**	
$LSD_{(0.05)}$ V		**0.05**			**0.07**			**ns**			**ns**	
T		**0.05**			**0.05**			**0.05**			**0.06**	
VxT		**0.07**			**0.07**			**0.07**			**0.08**	
	Vitamin C (mg $100g^{-1}$ fruits)						TSS (%)					
0	14.84	17.42	**16.13**	15.20	16.90	**16.05**	4.13	4.13	**4.13**	4.00	4.25	**4.13**
5	19.50	18.23	**18.87**	17.06	17.55	**17.31**	4.25	4.33	**4.29**	4.50	4.25	**4.38**
10	20.01	19.24	**19.62**	20.48	18.28	**19.38**	4.38	4.50	**4.44**	4.63	4.38	**4.51**
15	21.48	21.94	**21.71**	20.64	21.13	**20.88**	4.50	4.75	**4.63**	4.63	4.75	**4.69**
20	19.34	20.49	**19.92**	18.20	19.99	**19.09**	4.48	4.74	**4.61**	4.60	4.71	**4.66**
30	18.69	20.18	**19.44**	17.55	18.20	**17.88**	4.25	4.58	**4.42**	4.00	4.25	**4.13**
Mean	**18.98**	**19.58**		**18.19**	**18.67**		**4.33**	**4.51**		**4.40**	**4.43**	
$LSD_{(0.05)}$ V		**n.s.**			**n.s.**			**ns**			**ns**	
T		**0.51**			**0.63**			**0.43**			**0.29**	
VxT		**0.87**			**0.91**			**0.61**			**0.41**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

Finally, from the previous results of this investigation, it could be concluded that the growth, yield and quality as well as chemical composition of the tested tomato hybrids (grown under reclaimed soil conditions) were enhanced as rate of applied Mg increased till $15mgL^{-1}$ with the superiority of GLX hybrid.

Table (6): Effect of foliar application of magnesium on nitrogen, phosphorus, potassium and calcium concentration(%) of tomato plants in both seasons of 2007 and 2008.

Mg levels (mgL^{-1})	2007 Saria	2007 GLX	2007 Mean	2008 Saria	2008 GLX	2008 Mean	2007 Saria	2007 GLX	2007 Mean	2008 Saria	2008 GLX	2008 Mean
	N(%)						P(%)					
0	2.67	2.84	**2.76**	2.70	2.78	**2.74**	0.37	0.38	**0.38**	0.39	0.37	**0.38**
5	2.78	2.95	**2.87**	2.84	2.90	**2.87**	0.42	0.40	**0.41**	0.41	0.38	**0.40**
10	2.94	3.09	**3.02**	2.92	3.05	**2.99**	0.44	0.48	**0.46**	0.46	0.44	**0.45**
15	3.36	3.36	**3.36**	3.38	3.36	**3.37**	0.54	0.59	**0.57**	0.58	0.58	**0.58**
20	3.31	3.34	**3.33**	3.36	3.30	**3.33**	0.51	0.56	**0.54**	0.56	0.57	**0.57**
30	3.16	3.20	**3.18**	3.19	3.20	**3.20**	0.48	0.51	**0.50**	0.50	0.53	**0.52**
Mean	**3.04**	**3.13**		**3.07**	**3.10**		**0.46**	**0.49**		**0.48**	**0.48**	
$LSD_{(0.05)}$												
V		**ns**			**ns**			**ns**			**ns**	
T		**0.07**			**0.08**			**0.05**			**0.06**	
VxT		**0.10**			**0.12**			**0.07**			**0.09**	
	K(%)						Ca(%)					
0	1.89	1.96	**1.93**	1.85	1.93	**1.89**	2.71	2.94	**2.83**	2.80	2.88	**2.84**
5	1.94	2.04	**1.99**	1.90	2.00	**1.95**	2.85	3.24	**3.05**	2.86	2.95	**2.91**
10	1.97	2.09	**2.03**	1.96	2.11	**2.04**	3.03	3.46	**3.25**	3.00	3.27	**3.14**
15	2.29	2.47	**2.38**	2.25	2.40	**2.33**	3.35	3.67	**3.51**	3.26	3.52	**3.39**
20	2.26	2.42	**2.34**	2.20	2.38	**2.29**	3.22	3.58	**3.40**	3.16	3.42	**3.29**
30	2.17	2.26	**2.22**	2.14	2.23	**2.19**	3.09	3.49	**3.29**	3.12	3.40	**3.26**
Mean	**2.09**	**2.21**		**2.05**	**2.18**		**3.04**	**3.40**		**3.03**	**3.24**	
$LSD_{(0.05)}$												
V		**0.02**			**0.03**			**0.21**			**0.14**	
T		**0.07**			**0.08**			**0.14**			**0.08**	
VxT		**0.10**			**0.11**			**n.s.**			**0.11**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

Table (7): Effect of foliar application of magnesium on magnesium concentration(%) of tomato plants in both seasons of 2007 and 2008.

Mg levels (mgL^{-1})	2007 Saria	2007 GLX	2007 Mean	2008 Saria	2008 GLX	2008 Mean
	Mg(%)					
0	0.34	0.34	**0.34**	0.34	0.35	**0.35**
5	0.34	0.35	**0.35**	0.35	0.37	**0.36**
10	0.36	0.38	**0.37**	0.36	0.39	**0.37**
15	0.36	0.38	**0.37**	0.37	0.40	**0.39**
20	0.39	0.40	**0.40**	0.38	0.41	**0.40**
30	0.40	0.42	**0.41**	0.39	0.43	**0.41**
Mean	**0.37**	**0.38**		**0.37**	**0.39**	
$LSD_{(0.05)}$ V		**0.01**			**0.01**	
T		**0.01**			**0.01**	
VxT		**0.01**			**0.01**	

(V): for varieties (T): for magnesium rates
(VxT): for interaction between varieties and magnesium rates

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إستجابة نباتات الطماطم النامية تحت ظروف الأراضى المستصلحة للرش الورقى بعنصر الماغنسيوم

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أجريت تجربة حقلية فى موسمين متتالين هما ٢٠٠٧-٢٠٠٨ فى مزرعة خاصة- الفيوم- مصر لدراسة تأثير الرش الورقى بعنصر الماغنسيوم على نباتات الطماطم النامية تحت ظروف الأراضى المستصلحة. لإنجاز هذة الدراسة فقد تم زراعة صنفين من هجن الطماطم هما Saria, GLX مع الرش الورقى بعنصر الماغنسيوم (فى الصورة المخلبية) بالتركيزات ٥، ١٠، ١٥، ٢٠، ٣٠ ملليجرام/لتر.

وتشير النتائج المتحصل عليها إلى:

- وجود إختلاف واضح بين صنفى الطماطم محل الدراسة فى كافة الصفات التى تم دراستها (النمو– المحصول– المكونات الكيماوية) تحت تأثير الرش الورقى بعنصر الماغنسيوم.
- أدى الرش الورقى بعنصر الماغنسيوم إلى حدوث زيادة فى كل الصفات التى تم دراستها ووصلت إلى أعلى قيمة لها برش النباتات بعنصر الماغنسيوم بتركيز ١٥ ملليجرام/لتر ثم حدوث إنخفاض فى قيم هذه الصفات بالتركيزات الأعلى (٢٠، ٣٠ ملليجرام/لتر)، عدا تركيز عنصر الماغنسيوم فى الأوراق والذى زاد بزيادة التركيز عن ١٥ ملليجرام/لتر.
- حدوث تأثير إيجابى لمعاملات التفاعل بين عنصر الماغنسيوم والأصناف المستخدمة فى الدراسة، فقد وجد أن الصنف Saria المعامل بتركيز١٥ ملليجرام/لتر ماغنسيوم سجل أعلى القيم لمعظم صفات النمو المدروسة (الوزن الجاف للأوراق/نبات- وزن الأفرع الجافة/نبات- المساحة الورقية للنبات) فى موسمى الدراسة، أما عدد أوراق النبات والوزن الجاف للمجموع الخضرى/نبات فقد سجلت أعلى القيم فى الموسم الأول فقط.
- أظهر الصنف GLX تفوقاً فى محصول الثمار وعدد الثمار وذلك مقارنة بالصنف Saria والذى أظهر تفوقاً فى عدد الثمار فقط.
- أدى الرش الورقى بعنصر الماغنسيوم (مقارنة بالكنترول) إلى حدوث زيادة فى محتوى الأوراق من الكلورفيل الكلى- الكاروتينويدات- والنسبة المئوية من النيتروجين و البوتاسيوم والفوسفور والماغنسيوم والكالسيوم وكذلك محتوى الثمار من فيتامين ج- الحموضة الكلية- نسبة المواد الصلبة الذائبة الكلية وذلك لكلاً الصنفين مع زيادة تركيز هذه المكونات بزيادة تركيز الماغنسيوم المستخدم فى رش النباتات.
- سجل الصنف GLX أعلى القيم فى المكونات الكيماوية التى تم دراستها مقارنة بالصنف Saria فى كلا موسمى الدراسة.
- تشابه تأثيرالرش بتركيز١٥ ملليجرام/لتر على كلا الصنفين المستخدمين فى الدراسة حيث سجلت أعلى القيم للصفات التى تم دراستها لكلا الصنفين بإستعمال هذا التركيزخلال موسمى الدراسة.
- **أخيراً**... فإن هذه الدراسة تشير إلى أن الرش الورقى بعنصر الماغنسيوم بتركيز١٥ ملليجرام/لتر أدى إلى الحصول على أعلى محصول بجودة عالية من نباتات الطماطم النامية تحت ظروف الأراضى المستصلحة مع تفوق الهجين GLX فى هذا الشأن عن مثيله الهجين Saria.