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IMPACT OF ORGANIC FERTILIZATION AND SOME ANTITRANSPIRANTS TREATMENTS ON GROWTH, YIELD AND QUALITY OF EGGPLANT UNDER SALINE SOIL CONDITIONS

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Abstract
A field experiment was carried out at a private Farm in Rowad Village belong to Sahl El-Husseiniya, Sharkia Governorate during the two growing seasons of 2017 and 2018 to study the effect of organic fertilization (crushed rice straw "CRS" treated with urea at levels of 120 or 240 Kg and composted 90 days) and foliar spraying with some antitranspirants (magnesium carbonate and Kaolin) on vegetative growth, yield and its components as well as chemical constituents of eggplant either leaves or fruits c.v Black Beauty cultivar grown under saline soil conditions. The experiment was carried out by using split-plots system in a randomized complete blocks design with three replications. The main-plots were arranged with organic fertilization treatments. While, the sub-plots assigned to foliar spraying with some antitranspirants compounds. The obtained results of this investigation can be summarized as follows:
-Vegetative growth, yield , its components and chemical constituents of either the leaves or in the fruits of eggplant were significantly influenced by different crushed rice straw (CRS) levels treated with urea and fermented 90 days in the both seasons. The maximum values of these characters were produced from using crushed rice straw at 4.8 t/ha and mixed with 240 kg urea 46% N, followed by using creshed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N in both seasons.
-Foliar spraying eggplant plants with magnesium carbonate at 2% and Kaolin at 2% as antitranspirants compounds significantly improved vegetative growth, the yield and its components as well as the chemical constituents either in the leaves or in the fruits compared with the control treatment during both seasons. The highest values of these traits were resulted by using Kaolin at 2% in both seasons.
-The favourable results of growth, yield and its components as well as the chemical constituents in the leaves or the fruits were obtained from treatment of the interaction between using crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and foliar spraying with Kaolin at 2%, which gave the highest results.
For that, it could be recommended that using crushed rice straw at the rate of 4.8 t/ha and mixed with 240 kg urea 46% N which composted 90 days and adding it befor transplanting and foliar spraying the eggplant plants grown under saline soil conditions with Kaolin at 2% three times starting at 25 days after transplanting and repeated every 15 days intervals to enhance vegetative growth characters, yield and its components as well as the chemical constituents of eggplant fruits under the environmental condition of this research i.e soil salinty.

Keywords: Antitranspirants, Crushed rice straw, Eggplant, Organic fertilization

1. INTRODUCTION

Eggplant (*Solanum melongea* L.) is one of the oldest and popular vegetable crops in Egypt. It is grown in most cultivated area in Egypt for local consumption as well as for exportation. Eggplant fruits contain a considerable amount of carbohydrates, protein and vitamins (Mahamoud, 2000).
Increasing eggplant production under saline soil conditions facing an serious problem, Because, salinity is individual of the main abiotic stresses into arid and semi-arid regions that sustainability

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diminished the yield of major crops by extra 50%. Whereas, salinity conditions cause a decrease in uptake availability of most nutrients to the plants and this due to soil fixation for most elements. Moreover, all soil types contain soluble salts of a multifaceted nature when soil and environmental conditions allow soil salinity concentrations to reach high level in this case, it become a major threat to land degradation and crop productivity (Munnus, 2002).

Organic manures may increase soil fertility and thus reflect on the crop production potential possibly by changes in the soils physical and chemical properties including nutrient bioavailability, soil structure, water holding capacity, cation exchange capacity, reduce soil pH, microbial community and activity (Muhammad and Khattak, 2009). In particular, soil pH is greatly influenced by addition of organic manures through different organic amendments like crushed rice straw. crushed rice straw is important natural resource and recycling of rice straw residues which improves soil physical, chemical and biological properties (Mandal *et al.*, 2004 and Brar and Walia, 2010) generally and physic-chemical and microbiological properties of saline soil particularly (Dileep *et al.*, 2006). Singh (2004) revealed that rice residues proved highly beneficial for crop growth. Ismail (2013) found that application threshed rice straw in saline soil caused significant increases on growth, yield and quality of eggplant as compared with the control treatment (without threshed rice straw). El-Semellawy and El-Koumy (2015) stated that organic mulch treatments (rice straw, wheat straw and dry grass as well as the bare soil as a control) had a positive effect on vegetative growth parameters, total yield and fruit quality as compared with bare soil, which had the highest early yield. Ahmed *et al.* (2016) reported that mixing 50% amount of mineral fertilizers and organic fertilizers obtained the highest values of vegetative growth and fruit yield in the both growing seasons. Paul *et al.* (2017) showed that the fruit yield of eggplant was high in the combined application of organic and inorganic fertilizer and significantly different from either sole organic or inorganic nutrient sources or control.

Regarding to antitranspirants, in general, reduce the transpiration loss of water occurring mainly through closing stomatal pores present on leaf surface. Spraying with antitransparent materials results in higher relative water content and water use efficiency in association with lower rate of water use per day and consumptive use by coating film on the leaves, which increases the leaf reflectance by reflecting the radiation and increases the vapour pressure gradient and thus reduces transpiration (Glenn *et al.*, 2002 and Creamer *et al.*, 2005), consequently enhances crop growth and yield. Kaolin is an important material used in this concern, it is considered as an effective natural antitranspirant and was reported to mitigate the negative effects of water deficiency and environmental stresses, such as heat stress and sunburn damage (Kahn and Damicone, 2008). Kaolin increase photosynthesis and water use efficiency in grapefruit and reduce the water losses during vegetable growth period and before or after fruits harvesting in tuberose plant (Al-Moftah and Al-Hamaid, 2005). Also, Kaolin cause a reduction in leaf temperature of peach tree, while having no adverse effects on fruit yield and quality (Glenn *et al.*,1999) and reduce severity of sunburn damage in pomegranate fruit (Weerakkody *et al.*, 2010). Moreover, Anwar (2005) stated that application of antitranspirants such as kaolin and whitewash ($CaCO_3$) to potato plants could reduce transpiration by increasing leaf resistance to diffusion of water vapor. In addition, Creamer *et al.* (2005) illustrated that application of kaolin at hot temperatures might help hot Chile pepper plants from being subjected to severe water stress. Greger *et al.* (2011) found that the beneficial effects of aluminum silicate on plant growth may refer to that silicon enhances the growth, improves protection against pathogens and maintains of photosynthetic activity and that one of the reasons of increasing dry matter production. Boari *et al.* (2013) monitored that kaolin cause the great impact on eggplant growth by decreasing stomatal conductance, which contributes

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to reduced transpiration, improves plant water status and lower net assimilation. In addition, performing well in pest control and heat stress mitigation, kaolin can effectively be used as an antitranspirant to decrease the impact of salinity, heat stress and to save water. Rakha (2014) showed that application of antitranspirants (kaolin, potassium silicate and dyriton) significantly increased most of yield parameters of eggplant. The highest values were recorded with sprayed dyriton 4 % as compared with the other treatments. Bedrech and Farag (2015) found that spraying grapes with kaolin 5% improved cluster weight of berries under high temperature and irradiance levels conditions. Abd El-Hady and Doklega (2017) showed that using jojoba oil as antitranspirant foliar spray gave significant superiority comparing to other spraying treatments (control, kaolin, glycerol and green miracle) on vegetative growth measurements, yield and its components of eggplant, while green miracle produced the highest significant values of parameters quality *i.e.* crude protein, total carbohydrates, crude fiber and vitamin C. Ramadan and Omar (2017) revealed that antitranspirants foliar application significantly increased growth, yield and NPK content of cabbage. The beneficial effect of antitranspirants foliar application can be arranged as follows: $CaCO_3$ > kaolin > K_2SO_4 > plastic film > mineral oil as compared with the untreated plants. Zakher (2017) found that foliar spraying tomato plants with aluminum silicate (Kaolin) at 2% significantly increased all traits of vegetative growth, fruit setting, total yield, fruit weight, high firmness, high vitamin-C content and TSS % in juice fruits. Koteswara-Rao *et al.* (2018) stated that antitranspirants are important chemicals for spraying on transpiring plant surfaces with an attempt to reduce water use by reducing transpiration. Depending upon their mode of action, they are stomatal closing type, film forming type, reflectance type and growth retardants. Antitranspirants should have some of the ideal properties like non toxic, cheap, stable, long lasting in their effectiveness and they should have some of the assured benefits.

Therefore, the aim of this investigation was to determine the effect of organic fertilization (crushed rice straw treated with urea as organic fertilizers) and foliar spraying with some antitranspirants on vegetative growth, yield and its components along with chemical constituents of eggplant fruits under the ecological condition and salinity soil of Sahl El-Husseiniya, Sharkia Governorate.

2. MATERIALS AND METHODS

The present study was carried out during 2017 and 2018 seasons at a private Farm in Rowad Village belong to Sahl El-Husseiniya, Sharkia Governorate. The main goal of this trial was to clarify the effect of organic fertilization (crushed rice straw "CRS" levels treated with urea and fermented for 90 days) and foliar spray by some antitranspirants treatments on vegetative growth, yield and its components and chemical constituents of eggplant, Black Beauty cultivar.

The experiment layout was a split-plots system in a randomized complete blocks design with three replications. The main-plots were arranged with three organic fertilization treatments as follows:

A- The first treatment was organic fertilization as follows:

1- Without organic fertilization (control treatment).
2- Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/ha treated by 120 kg urea 46% N and fermented (90 days) in the presence of water spray.
3- Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/ha treated by 240 kg urea 46% N and fermented (90 days) in the presence of water spray .

Organic fertilizers were added to the experimental units before transplanting in the interior of ridges and then turned over via hack. The chemical analysis of crushed rice straw (CRS) used in the two growing seasons is showed in Table 1.

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Table 1. Chemical analysis of crushed rice straw (CRS) during the two growing seasons

Contents	crushed rice straw (CRS)	
	2017	2018
Organic matter (OM) %	44.30	42.60
C %	25.80	26.9
N %	1.09	1.07
C/N	23 : 7	23 : 2
P %	0.19	0.18
K %	0.14	0.13
pH (1 : 5)	4.90	4.80
EC (1 : 10)	5.10	5.20

B-The second treatment was foliar spray with some antitranspirants as follows:
The sub-plots were assigned to foliar spraying with some antitranspirants *i.e.* tap water (control treatment), magnesium carbonate ($MgCO_3$) and Kaolin (Aluminum silicate, Si2 48.8 ml/g + Al2O7 7%). Foliage application of the used antitranspirants as powder agriculture grade were used as a fine mist foliar application at 2% (20 g/L) till run-off with care being taken to cover all plant foliage (Zakher, 2017) at three times starting at 25 days after transplanting and repeated every 15 days intervals during the two growth seasons.
Each experimental unit contains 4 rows, 3.75 m long and 0.70 m width occupying an area of 10.5 m^2 (*i.e.* 1/950 hectar). The previous crop was garlic (*Allium sativum* L.) in both seasons.
The experiments were carried out in a clay loam soil with medium fertility. Soil samples were randomly selected from the experimental field area at a depth of 0-50 cm prior to soil preparation to determine physical and chemical soil characteristics as shown in Table 2.

Table 2. Physical and chemical soil characteristics of the experimental sites during the two growing seasons

Soil analyses		2017	2018
A: Mechanical analysis			
Clay (%)		51.00	54.00
Silt (%)		28.60	31.40
Fine sand (%)		18.70	14.80
Coarse sand (%)		2.10	2.89
Texture class		Clay	Clay
Organic matter (%)		1.44	2.81
B: Chemical analyseis			
pH (1 : 2.5)		7.78	8.01
E.C. dS m^{-1} (1 : 5)		5.07	4.90
Saturation percentage (SP %)		71.00	70.50
Available N (ppm)		45.50	47.1
Available P (ppm)		4.30	4.70
Exchangeable K (ppm)		375	226
Cations (meq/100 g soil)	Ca^{++}	1.25	2.25
	Mg^{++}	0.67	2.41
	Na^{+}	3.25	2.93
	K^{+}	0.31	0.16
Anions (meq/100 g soil)	CO_3^{--}	-	-
	HCO_3^{-}	0.98	3.61
	Cl^{-}	2.56	2.43
	SO_4^{--}	1.88	2.35

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The transplanting was carried out during the first week of May in both seasons. The seedlings (40 days old) transplanted on both sides of the ridges at 50 cm apart. The common recommended mineral fertilizers (N, P and K) were applied at the rate of 1070 kg ammonium sulfate (20.5 % N), 595 kg calcium superphosphate (15.5 % P_2O_5) and 350 kg potassium sulfate (48.52 % K_2O). All doses of these fertilizers were applied as following; 30 % at 4 weeks after transplanting, 35 % at 8 weeks after transplanting and 35 % at 12 weeks after transplanting. The harvest was done after 90 days from transplanting (every 5 days intervals until 45 day from beginning the harvest) in the both seasons of this study. The common agricultural practices for plantation eggplant was doing according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

The recorded data:

A- Vegetative growth characters:

At 70 days after transplanting a random sample of four guarded plants was taken from the inner rows from each sub-plot to estimate plant vegetative growth characters as follows:

1- Plant height (cm). 2- Number of leaves/plant. 3- Fresh and dry weight of leaves (g).

B- Yield and its components:

The harvest was done after 90 days from transplanting and continue 45 days through 9 pickings (the fruits were harvested every 5 days).The fruit yield and its characters are shown as follows.

1- Early yield weight in t/ha (first 3 pickings).
2- Yield weight in t/ha (from the fourth picking till end of harvesting (6 picking)).
3- Total yield weight in t/ha (early yield weight + yield weight).

Random samples of fruits at harvesting time (from the fourth picking) were in use from each sub-plot to decide the following traits:

1- Average fruit weight (g). 2- Average fruit diameter (cm). 3- Average fruit length (cm).

C- Chemical constituents:

Random samples of leaves at 70 days after transplanting were taken from each sub-plot to determine the following traits:

1- Total nitrogen content (%) was determined according to the method described by Pregle (1945) using micro-Kjeldahl.
2- Phosphorus content (%) was determined colorimetrically using the chlorostannus reduce molybdo phosphoric blue color method in sulphoric system as described by Jackson (1967).
3- Potassium content (%) was determined using a flame photometer according to Black (1965).
4- Proline % in the leaves was estimated according to A.O.A.C. (1990).
5- Total chlorophylls (SPAD): Leaf chlorophylls content was assessed by SPAD-502 (Minolta Co. Ltd., Osaka, Japan).

Random samples of fruits at harvesting time (from the fourth picking) were taken from each sub-plot to determine the following traits:

1- Total nitrogen, phosphorus and potassium content (%) in fruits were estimated as previously mentioned in leaves.
4- Total soluble solids (TSS %) was estimated using Gali 110 refractometer as mentioned by Brown and Zerban (1938).
5- Total iron was measured in the digested fruit samples using an Atomic Absorption spectrophotometer according to Chapman and Pratt (1961).

D- Economic feasibility:

The economic feasibility of eggplant plants as affected by organic fertilization (threshed rice straw fertilizers) and foliar spraying with some antitranspirants as well as their interaction.

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All data of this study were statistically analyzed according to the technique of variance for the split-plot design (Gomez and Gomez, 1984) by means of "MSTAT-C" Computer software package. LSD method was used to examination the differences among means of the treatment at 5 % level of probability (Snedecor and Cochran, 1980).

3. RESULTS AND DISCUSSIONS

A. Vegetative growth:

A.1- Organic fertilization treatments:

The data presented in Tables 3 and 4 show that organic fertilization treatments *i.e.* without organic fertilization (control treatment), application organic fertilizer 1 (crushed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N and fermented "90 days") and application organic fertilizer 2 (crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented "90 days") caused significant increases on vegetative growth characters (plant height, number of leaves/plant, fresh and dry weight of leaves) and the chemical constituents of the leaves (nitrogen, phosphorus, potassium, proline percentages and total chlorophylls) of eggplant after 70 days after transplanting in the two seasons of this study. The highest values of these growth traits were obtained by application of organic fertilizer 2 and followed by application of organic fertilizer 1 as compared with treatment without organic fertilization (control treatment) in both seasons. The enhancing effect due to application of crushed rice straw mixed with urea and decaying may be due to increase soil fertility and thus the crop production potential possibly by changes in the soils physical and chemical properties including nutrient bioavailability, soil structure, water holding capacity, cation exchange capacity, reduce soil pH, microbial community and its activity as mentioned by (Muhammad and Khattak, 2009). In addition, crushed rice straw fermented and mixed with urea is important natural resource and recycling of crushed rice straw which improves soil physical, chemical and biological properties (Mandal *et al.*, 2004). The obtained findings are in harmony with those of Singh (2004), Ismail (2013) and Ahmed *et al.* (2016) on eggplant.

Table 3. Plant height, number of leaves/plant, fresh and dry weight of leaves of eggplant plants after 70 days from transplanting as affected by organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments	Plant height (cm)		Number of leaves/plant		Fresh weight of leaves (g)		Dry weight of leaves (g)	
	2017	2018	2017	2018	2017	2018	2017	2018
A- Organic fertilizers:								
Without (control)	41.15	43.09	36.35	35.85	69.20	73.13	12.70	13.46
Organic fertilizer 1	44.07	46.12	40.59	42.60	81.18	86.12	15.56	16.52
Organic fertilizer 2	47.57	49.63	46.76	48.91	91.05	95.70	18.29	19.25
F. test	*	*	*	*	*	*	*	*
LSD at 5 %	1.79	0.62	1.30	0.74	0.43	1.40	0.57	0.71
B- Foliar spraying with some antitranspirants:								
Tap water (control)	41.54	43.94	37.81	38.57	71.87	77.05	13.69	14.59
Magnesium carbonate	43.69	45.83	41.46	42.50	80.61	84.36	15.28	16.24
Kaolin	47.16	48.71	44.43	46.29	88.96	93.53	17.57	18.40
F. test	*	*	*	*	*	*	*	*
LSD at 5 %	0.57	0.99	0.63	1.07	0.61	0.59	0.47	0.64

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/ha + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/ha + 240 kg urea 46% N (90 days).

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Table 4. Nitrogen, phosphorus, potassium, proline percentages and total chlorophylls in leaves of eggplant after 70 days from transplanting as affected by organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments	N (%)		P (%)		K (%)		Proline (%)		Total chlorophylls (SPAD)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A- Organic fertilizers:										
Without (control)	2.13	2.16	0.292	0.296	2.646	2.736	10.75	10.65	73.75	73.88
Organic fertilizer 1	2.50	2.53	0.316	0.323	2.980	3.040	9.63	9.48	74.55	74.61
Organic fertilizer 2	2.79	2.84	0.326	0.334	3.133	3.186	8.84	8.65	74.94	75.17
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.54	0.42	0.62	0.71	0.56	0.64	0.85	0.44	0.42	0.73
B- Foliar spraying with some antitranspirants:										
Tap water (control)	2.32	2.33	0.299	0.304	2.806	2.853	10.3	10.06	73.90	74.21
Magnesium carbonate	2.46	2.50	0.311	0.316	2.946	3.000	9.71	9.66	74.36	74.39
Kaolin	2.65	2.70	0.324	0.332	3.070	3.110	9.22	9.06	74.98	75.06
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.54	0.45	0.42	0.39	0.57	0.65	0.77	0.63	0.81	0.52

A.2- Effect of foliar spraying with some antitranspirants treatments:

The obtained results as presented in Tables 3 and 4 show that, in both seasons, foliar spraying with some antitranspirants *i.e.* tap water (control treatment), magnesium carbonate at 2% and Kaolin at 2% caused significant increases on vegetative growth characters (plant height, number of leaves/plant, fresh and dry weight of leaves) and chemical constituents of leaves (nitrogen, phosphorus, potassium, proline percentages and total chlorophylls) of eggplant after 70 days after transplanting. The highest values of these growth traits were obtained from foliar spraying eggplant plants with Kaolin at 2% in both seasons. The second best antitranspirants treatments was foliar spraying eggplant plants with magnesium carbonate at 2% in the two growing seasons. The lowest values of these growth traits were obtained from foliar spraying of eggplant plants with tap water (control treatment) in both seasons. These results may be due to that the Kaolin at 2% (Aluminum silicate) helps in increase the growth rate by coating film on the leaves, it increase the leaf reflectance by reflecting the radiation and increase the vapour pressure gradient and thus reduce transpiration (Glenn *et al.*, 2002 and Creamer *et al.*, 2005). In addition, Kaolin reduce the water losses during vegetable growth period and before or after fruits harvesting in tuberose plant(Al-Moftah and Al-Hamaid, 2005). These results are in agreement with those obtained by Greger *et al.* (2011), Boari *et al.* (2013), Abd El-Hady and Doklega (2017) on eggplant, Ramadan and Omar (2017) on cabbage and Zakher (2017) on tomato.

A.3- Effect of the interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments:

The interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments had a significant effect on vegetative growth characters (plant height, number of leaves/plant, fresh and dry weight of leaves) and chemical constituents of leaves (nitrogen, phosphorus, potassium, proline percentages and total chlorophylls) of eggplant after 70 days after transplanting in both seasons (Tables 5 and 6). The favourable interaction treatment that produced the highest values of vegetative growth characters and chemical constituents of leaves was using organic fertilizer 2 and foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. The second best interaction treatment was using organic fertilizer 1 with foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. On the other hand, the

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lowest means of these traits were resulted from control treatment of both studied factors (without organic fertilization and foliar spraying of eggplant plants with tap water) in both seasons. These results may be due to the role of crushed rice straw are important natural resource and recycling of these residues improves soil physical, chemical and biological properties (Mandal *et al.*, 2004 and Brar and Walia, 2010). Moreover, The beneficial effects of antitranspirants which lead to reduce water use by reducing transpiration depending upon their mode of action *i.e.* stomatal closing type, film forming type, reflectance type and growth retardants (Koteswara-Rao *et al.*, 2018).

Table 5. Plant height, number of leaves/plant, fresh and dry weight of leaves of eggplant plants after 70 days from transplanting as affected by the interaction between organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments		Plant height (cm)		Number of leaves/plant		Fresh weight of leaves (g)		Dry weight of leaves (g)	
		2017	2018	2017	2018	2017	2018	2017	2018
Without	Tap water	39.13	41.02	34.52	32.23	61.63	64.73	11.09	11.93
	Magnesium carbonate	40.28	43.15	36.37	35.87	69.52	73.83	12.45	13.49
	Kaolin	44.03	45.12	38.13	39.45	76.46	80.82	14.57	14.97
Organic fertilizer 1	Tap water	41.42	44.02	36.36	38.71	72.25	76.83	13.46	14.47
	Magnesium carbonate	43.39	45.81	41.14	42.78	80.74	87.04	15.73	16.74
	Kaolin	46.23	47.43	44.28	46.32	90.56	94.49	17.48	18.35
Organic fertilizer 2	Tap water	44.08	46.79	42.54	44.78	81.74	89.58	16.52	17.37
	Magnesium carbonate	47.41	48.54	46.87	48.86	91.57	92.23	17.67	18.49
	Kaolin	51.22	53.58	50.89	53.09	99.86	105.29	20.68	21.89
F. test		*	*	*	*	*	*	*	*
LSD at 5 %		1.412	1.308	1.208	0.958	0.753	0.870	1.107	1.147

Table 6. Nitrogen, phosphorus, potassium, proline percentages and total chlorophylls in leaves of eggplant after 70 days after transplanting as affected by the interaction between organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments		N (%)		P (%)		K (%)		Proline (%)		Total chlorophylls (SPAD)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Without	Tap water	2.00	2.01	0.286	0.284	2.64	2.67	11.25	11.06	73.51	73.72
	Magnesium carbonate	2.15	2.19	0.292	0.294	2.70	2.72	10.90	10.87	73.63	73.69
	Kaolin	2.25	2.28	0.299	0.311	2.78	2.82	10.12	10.03	74.13	74.24
Organic fertilizer 1	Tap water	2.32	2.36	0.298	0.306	2.83	2.84	10.34	10.10	73.72	74.14
	Magnesium carbonate	2.45	2.49	0.317	0.324	2.97	3.09	9.42	9.33	74.68	74.54
	Kaolin	2.73	2.75	0.333	0.339	3.15	3.20	9.13	9.01	75.25	75.17
Organic fertilizer 2	Tap water	2.61	2.64	0.313	0.323	2.95	3.05	9.31	9.03	74.47	74.78
	Magnesium carbonate	2.79	2.83	0.325	0.332	3.17	3.20	8.81	8.80	74.78	74.95
	Kaolin	2.98	3.07	0.341	0.346	3.28	3.31	8.41	8.14	75.57	75.79
F. test		*	*	*	*	*	*	*	*	*	*
LSD at 5 %		0.23	0.30	0.630	1.155	1.06	0.79	0.647	0.775	0.930	0.850

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/ha + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/ha + 240 kg urea 46% N (90 days).

B. Yield and its components:

B.1- Organic fertilization treatments:

As shown from data in Table 7, application of organic fertilizers (organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N and fermented"90 days " and organic

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fertilizer 2 *i.e.* crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented "90 days ") caused significant increases on yield and its components *i.e.* early yield weight (the first 3 pickings t/ha), yield weight (from the fourth picking till end of harvesting t /ha), total yield/ha, fruit weight, diameter and length of eggplant fruits as compared to without adding organic fertilization (control treatment) in both seasons. Using organic fertilizer 2 produced the highest values of these traits of yield and its components in both seasons. However, application organic fertilizer 1 produced the second highest values of these traits of yield and its components in both seasons. While, the lowest values of yield and its components were resulted from the control treatment (without organic fertilization) in both seasons. The improvement in yield and its components due to organic fertilization treatments might be ascribed to the merge beneficial effects of crushed rice straw as important natural resource and recycling of rice straw residues which improves soil physical, chemical and biological properties (Mandal *et al.*, 2004 and Brar and Walia, 2010) generally and physic-chemical and microbiological properties of saline soil particularly (Dileep *et al.*, 2006). These results are in harmony with those of Ismail (2013) and Paul *et al.* (2017) on eggplant.

B.2- Effect of foliar spraying with some antitranspirants treatments:

As shown from data in Table 7 that foliar spraying eggplant plants with magnesium carbonate at 2% and Kaolin at 2% caused significant increases on fruit yield and its components of eggplant *i.e.* early yield weight, yield weight and total yield/fed, fruit weight, diameter and length as comparing with foliar spraying of eggplant plants with tap water (control treatment) in both growing seasons. Foliar spraying eggplant plants with Kaolin at 2% produced the highest values of yield and its components. While, foliar spraying eggplant plants with magnesium carbonate at 2% produced the second best values of yield and its components in both seasons. Conversely, control treatment (foliar spraying eggplant plants with tap water) produced the lowest means of yield and its components in both seasons.

Table 7. Early yield weight, yield weight and total yield/fed, fruit weight, diameter and length of eggplant as affected by organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments	Early yield weight (t/ha)		Yield weight (t/ha)		Total yield (t/ha)		Fruit weight (g)		Fruit diameter (cm)		Fruit length (cm)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A- Organic fertilizers:												
Without (control)	3.89	4.26	7.61	7.90	11.50	12.16	29.97	32.07	2.85	2.88	9.03	9.15
Organic fertilizer 1	4.54	5.05	8.90	8.86	13.44	13.91	34.20	35.96	2.95	2.99	9.83	9.91
Organic fertilizer 2	5.01	5.03	10.76	11.42	15.77	16.45	39.25	40.99	3.12	3.15	10.65	10.93
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.79	2.15	1.61	1.29	1.54	2.96	2.01	1.16	0.44	0.61	0.53	0.78
B- Foliar spraying with some antitranspirants:												
Tap water (control)	4.01	4.36	8.13	8.28	12.14	12.64	30.75	32.27	2.86	2.90	9.22	9.32
Magnesium carbonate	4.40	4.95	8.91	9.06	13.31	14.01	34.13	35.67	2.97	3.00	9.64	9.91
Kaolin	5.03	5.03	10.23	10.84	15.26	15.86	38.54	40.32	3.09	3.12	10.65	10.87
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.74	1.25	1.61	2.51	1.79	1.48	1.41	1.66	0.45	0.57	0.68	0.86

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/hectar + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/hectar + 240 kg urea 46% N (90 days).

These results may be due to the influence of Kaolin (Aluminum silicate) which it is an important material used in this concern, it is considered as an effective natural antitranspirant and was reported to mitigate the negative effects of water deficiency and environmental stresses, such as heat stress and sunburn damage (Kahn and Damicone, 2008). In addition Kaolin increase

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photosynthesis and water use efficiency in grapefruit and reduce the water losses during vegetable growth period and before or after fruits harvesting in tuberose plant (Al-Moftah and Al-Hamaid, 2005). Also, Kaolin cause a reduction in leaf temperature of peach tree, while having no adverse effects on fruit yield and quality (Glenn *et al.*,1999) and reduce severity of sunburn damage in pomegranate fruit (Weerakkody *et al.*, 2010). These results are in agreement with those obtained by Rakha (2014), Abd El-Hady and Doklega (2017) and Ramadan and Omar (2017) on eggplant and Zakher (2017) on tomato.

B.3- Effect of the interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments:

The interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments had a significant effect on all studied characters of fruit yield and its components as shown from the data in Table 8. The favourable interaction treatment that produced the highest values of early yield weight (first 3 pickings), yield weight (from the fourth picking till end of harvesting) and total yield of early yield and yield weight and its components was obtained by using crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented (90 days) with foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. The second best interaction treatment was using crushed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N and fermented (90 days) with foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. Conversely, the lowest means of these traits were resulted from control treatment of both studied factors (without organic fertilization and foliar spraying of eggplant plants with tap water) in both seasons. These results may be due to the role of the crushed rice straw mixed with urea which improved the physic-chemical and microbiological properties of saline soil. It is important natural resource and recycling of these residues improves soil physical, chemical and biological properties. Soil pH is greatly influenced by addition of organic matter (OM) through different organic amendments. Moreover, applications of kaolin at hot temperatures might help hot Chile pepper plants from being subjected to severe water stress (Creamer *et al.*,2005). Also, Kaolin cause a reduction in leaf temperature of peach tree, while having no adverse effects on fruit yield and quality (Glenn *et al.*,1999) and reduce severity of sunburn damage in pomegranate fruit (Weerakkody *et al.*, 2010).

Table 8. Early yield weight, yield weight and total yield/fed, fruit weight, diameter and length of eggplant as affected by the interaction between organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments		Early yield weight (t/ha)		Yield weight (t/ha)		Total yield (t/ha)		Fruit weight (g)		Fruit diameter (cm)		Fruit length (cm)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Without	Tap water	3.50	4.24	6.63	6.40	10.13	10.64	25.54	28.27	2.78	2.82	8.62	8.66
	Magnesium carbonate	3.67	3.93	7.25	7.69	10.92	11.62	29.65	31.76	2.84	2.86	8.70	8.79
	Kaolin	4.49	4.62	8.96	9.61	13.45	14.23	34.73	36.19	2.92	2.95	9.78	9.99
Organic fertilizer 1	Tap water	3.32	3.96	8.60	8.20	11.93	12.16	31.46	33.29	2.82	2.86	9.15	9.21
	Magnesium carbonate	4.55	5.57	8.75	8.35	13.30	13.93	33.57	34.99	2.92	2.96	9.71	9.98
	Kaolin	5.75	5.61	9.33	10.02	15.08	15.64	37.56	39.59	3.11	3.15	10.65	10.89
Organic fertilizer 2	Tap water	5.20	4.89	9.14	10.24	14.35	15.13	35.24	37.53	2.98	3.02	9.89	10.09
	Magnesium carbonate	4.97	5.35	10.74	11.14	15.73	16.49	39.17	40.27	3.14	3.19	10.51	10.96
	Kaolin	4.86	4.85	12.39	12.87	17.25	17.72	43.34	45.17	3.23	3.25	11.53	11.73
F. test		*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %		1.25	0.98	2.98	1.38	2.62	2.97	1.153	0.872	0.56	0.63	0.489	0.650

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/hectar + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/hectar + 240 kg urea 46% N (90 days).

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C. Chemical constituents of fruits:

C.1- Organic fertilization treatments:

Chemical constituents of fruits taken from the fourth picking to determine nitrogen, phosphorus, potassium, total soluble solids percentages and total iron content showed significant influences by application of organic fertilization treatments *i.e*, organic fertilizer 1 (crushed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N and fermented "90 days ") and application organic fertilizer 2 (crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented "90 days ") in both seasons as shown in Table 9. The highest values of these quality traits were obtained by application organic fertilizer 2 in both seasons. While, the second highest values of fruits quality characters were obtained by application organic fertilizer 1 treatment in both seasons. Also the lowest values of fruits quality characters of eggplant were resulted from control treatment (without organic fertilization) in both seasons. The enhancing effect of application crushed rice straw mixed with urea and decomposing may be due to decaying organic manures may increase soil fertility and thus the crop production potential possibly by changes in the soils physical and chemical properties including nutrient bioavailability, soil structure, water holding capacity, cation exchange capacity, reduce soil pH, microbial community and activity (Muhammad and Khattak, 2009). The obtained results are in accordance with those of Ismail (2013) and El-Semellawy and El-Koumy (2015) on eggplant.

C.2- Effect of foliar spraying with some antitranspirants treatments:

Chemical constituents of fruits taken from the fourth picking to determine nitrogen, phosphorus, potassium, total soluble solids percentages and total iron content showed significant influences by foliar spraying of eggplant plants with magnesium carbonate or Kaolin at 2% as comparing with foliar spraying eggplant plants with tap water (control treatment) in both seasons as shown in the data presented at Table 9. Foliar spraying of eggplant plants with Kaolin at 2% produced the highest values of these fruits quality traits in the two growing seasons of this study. While, foliar spraying of eggplant plants with magnesium carbonate at 2% produced the second best values of chemical constituents of fruits in both seasons. The control treatment (foliar spraying of eggplant plants with tap wat) resulted in the lowest means of chemical constituents of fruits taken from the fourth picking in both seasons.

Table 9. Nitrogen, phosphorus, potassium, total soluble solids (TSS) percentages and total iron (Fe) content in eggplant fruits at harvesting time as affected by organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments	N (%)		P (%)		K (%)		TSS (%)		Fe (ppm)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A- Organic fertilizers:										
Without (control)	2.08	2.13	0.224	0.232	2.48	2.51	4.25	4.29	27.71	28.69
Organic fertilizer 1	2.24	2.28	0.243	0.249	2.60	2.63	4.40	4.46	29.83	30.37
Organic fertilizer 2	2.42	2.47	0.263	0.268	2.67	2.69	4.55	4.61	31.14	31.66
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.425	0.723	0793.	2.031	1.056	0.763	1.309	0.527	0.672	0.492
B- Foliar spraying with some antitranspirants:										
Tap water (control)	2.13	2.16	0.226	0.235	2.51	2.54	4.27	4.31	28.07	29.05
Magnesium carbonate	2.24	2.28	0.241	0.248	2.58	2.60	4.40	4.43	29.58	29.97
Kaolin	2.38	2.44	0.263	0.266	2.66	2.69	4.54	4.61	31.03	31.69
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.098	2.136	0.642	1.267	2.046	1.368	0.734	1.046	1.390	0.985

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/hectar + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/hectar + 240 kg urea 46% N (90 days).

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These results may be due to the effect of aluminum silicate on plant growth may refer to that silicon enhances the growth, improves protection against pathogens and maintains of photosynthetic activity and that one of the reasons of increasing dry matter production. These results are in agreement with those obtained by Abd El-Hady and Doklega (2017) on eggplant, Ramadan and Omar (2017) on cabbage and Zakher (2017) on tomato.

C.3- Effect of the interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments:

The interaction between organic fertilization treatments and foliar spraying with some antitranspirants treatments had a significant effect on all studied characters of chemical contents of eggplant fruits taken from the fourth picking (nitrogen, phosphorus, potassium, total soluble solids percentages and total iron content) as shown in Table 10. The favourable interaction treatment that produced the highest values of chemical contents of fruits was obtained by using crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented (90 days) and foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. The second best interaction treatment was by using crushed rice straw at 2.4 t/ha mixed with 120 kg urea 46% N and fermented (90 days) with foliar spraying eggplant plants with Kaolin at 2% in both seasons of this study. Conversely, the lowest means of these traits were resulted from control treatment of both studied factors (without organic fertilization and foliar spraying of eggplant plants with tap water) in both seasons. These results possibly will be due to the responsibility of the crushed rice straw mixed with urea which improved the physic-chemical and microbiological properties of saline soil. Also, threshed rice straw are important natural resource and recycling of these residues improves soil physical, chemical and biological properties (Brar and Walia, 2010). Moreover, Kaolin is an important material used in this concern, it is considered as an effective natural antitranspirant and was reported to mitigate the negative effects of water deficiency and environmental stresses, such as heat stress and sunburn damage (Kahn and Damicone, 2008).

Table 10. Nitrogen, phosphorus, potassium, total soluble solids (TSS) percentages and total iron (Fe) content in eggplant fruits at harvesting time as affected by the interaction between organic fertilization treatments and foliar spraying with some antitranspirants during 2017 and 2018 seasons

Characters / Treatments		N (%)		P (%)		K (%)		TSS (%)		Fe (ppm)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Without	Tap water	1.99	2.03	0.210	0.217	2.41	2.40	4.15	4.20	26.14	27.16
	Magnesium carbonate	2.05	2.10	0.223	0.237	2.43	2.48	4.24	4.26	27.76	28.15
	Kaolin	2.20	2.25	0.240	0.243	2.58	2.62	4.36	4.40	29.24	30.76
Organic fertilizer 1	Tap water	2.14	2.16	0.223	0.236	2.52	2.54	4.25	4.31	28.53	29.45
	Magnesium carbonate	2.24	2.27	0.244	0.248	2.60	2.63	4.41	4.43	29.74	30.01
	Kaolin	2.33	2.42	0.261	0.264	2.68	2.72	4.55	4.63	31.21	31.66
Organic fertilizer 2	Tap water	2.25	2.30	0.245	0.252	2.61	2.64	4.40	4.43	29.53	30.55
	Magnesium carbonate	2.42	2.46	0.256	0.260	2.68	2.70	4.55	4.60	31.25	31.77
	Kaolin	2.60	2.64	0.287	0.292	2.72	2.74	4.71	4.80	32.63	32.66
F. test		*	*	*	*	*	*	*	*	*	*
LSD at 5 %		0.52	1.73	1.45	0.67	1.08	1.65	1.31	1.95	0.86	1.96

Organic fertilizer 1 *i.e.* crushed rice straw at 2.4 t/hectar + 120 kg urea 46% N (90 days).
Organic fertilizer 2 *i.e.* crushed rice straw at 4.8 t/hectar + 240 kg urea 46% N (90 days).

D- Economic feasibility:

The economic feasibility of eggplant plants as affected by organic fertilization treatments and foliar spraying with some antitranspirants as well as their interaction over both seasons are presented in

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Table 11. The results showed that the highest net return 28055 LE/ha over both seasons was obtained from application of crushed rice straw at 4.8 t/ha mixed with 240 kg urea 46% N and fermented (90 days) besides foliar spraying eggplant plants with Kaolin at 2 %, such treatment returns the highest benefit cost ratio (2.791) in comparison with the other treatments. Therefore, this treatment considered to be economical for eggplant production under soil salinity and the environmental condition of Sahl El-Husseiniya, Sharkia Governorate.

Table 11. Economic feasibility of eggplant production as affected by organic fertilization treatments and foliar spraying with some antitranspirants as well as their interaction over both seasons

Treatments \ Characters		Total yield (t/ha)(1)	Gross return (LE/ha)(2)	Treatment cost (LE/ha)(3)	Total variable cost (LE/ha)(4)	Net return (LE/ha)(5)	Benefit cost ratio(6)	Order
Without	Tap water	10.39	25964	-	12760	13205	2.034	9
	Magnesium carbonate	11.27	28169	571	13331	14838	2.113	8
	Kaolin	13.84	34600	286	13045	21555	2.652	3
Organic fertilizer 1	Tap water	12.04	30107	1310	14069	16038	2.139	7
	Magnesium carbonate	13.61	34036	1881	14640	19395	2.324	6
	Kaolin	15.36	38393	1595	14355	24038	2.674	2
Organic fertilizer 2	Tap water	14.74	36850	2619	15379	21471	2.396	5
	Magnesium carbonate	16.11	40279	3190	15950	24329	2.525	4
	Kaolin	17.49	43719	2905	15664	28055	2.791	1

(1) Eggplant total yield as average over both seasons. (2) Gross return as total yield (t/ha) x 2500 LE ton. (3) Treatment cost was calculated according to the following prices: Kaolin =250 LE/25kg; magnesium carbonate =20 LE/Kg; threshed rice straw =300 LE/ton; 50 Kg urea 48%=250 LE. (4) Total variable cost (LE/ha) include: Treatment cost plus land leasehold , transplant, N, P and K Fertilizers, microelements, pesticides, labors and other cultural practices which equal nearly 12760 LE/ha. (5) = (2) – (4). (6) = (2) / (4).

4. CONCLUSIONS

According to the obtained data in this study, it could be recommended that using crushed rice straw at the rate of 4.8 t/ha mixed with 240 kg urea 46% N and fermented (90 days) and adding it before transplanting as a soil application and foliar spraying eggplant plants with Kaolin at 2% three times starting at 25 days after transplanting and repeated every 15 days intervals to enhance vegetative growth characters, yield and its components and chemical constituents of eggplant fruits under the environmental conditions of saline soil in Sahl El-Husseiniya, Sharkia Governorate.

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