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Improvement Production of Eggplant under Siwa Oasis Conditions

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Abstract: The field work was carried out at the Experimental Farm of the Desert Research Center at Siwa Oasis, Marsa Matroh Governorate, during the two consecutive seasons of 2013/2014 and 2014/2015. The experiments were conducted to investigate the effect of soil amendments *i.e.*, humic acid at the rate of (1kg/fed.) and fulvic acid at the rate of (1kg/fed.) and three commercial anti-transpiration products *i.e.*, phospho X, anti-cool and green miracle as foliar application on growth, yield and chemical composition of eggplant plants, Blake beauty cv. grown in sandy soil conditions. Results revealed that the highest values of growth, yield parameters, N (%) and Fe content were cleared with humic acid application, no significant differences were found between humic and falvic acid on most parameters. The highest values of plant height and weight recorded with green miracle at the rate of 5m/L. The highest values of number of stems/plant and shoot dry matter were recorded with anti cool at the rate of 2m/L. foliar spray treatments surpassed significantly in chlorophyll content when compared with control treatment. Green miracle at the both rates (2.5 and 5 m/l) increased significantly on fruit number and weight, plant yield and total yield as compared with control treatment. Moreover, Phospho X treatment at the rate of 1.5 m/L surpassed significant on P (%) and Fe (ppm) content. Anatomy of leaves indicated that there were effected for both soil amendments and spray application on all investigated leaves anatomy parameters.

Keywords: Eggplant acid – fulvic acid - Anti-transpiration – Growth – Yield – chemical composition.

1. Introduction

Siwa Oasis is located in the northern part of the Western Desert of Egypt. The total cultivated area is (20940 fed.). It is characterized by hot and dry climate conditions. The Oasis displays numerous landforms: salt marshes, salt lakes and cultivated lands. The main activity in Siwa Oasis is agriculture which is depending on the groundwater and flood irrigation system, in all most agricultural areas.

Eggplant (*Solanum melongena* L.) is one of the Solanaceae plants and considered as one of the cultivated vegetable crops in many regions of the world, including tropical regions like India, China and Middle East Region, it is popular food and used for cooking aims and after processing to control liver suffer because it enhances clostrin changes and lowers its activity. It is considered as a rich crop in carbohydrates, minerals and protein [1]**.**

Humic substances are a heterogeneous mixture of naturally occurring organic materials that arise from the decay of plants and animal residues. These humic substances in soil are commonly referred to as organic matter or humus. Humus is comprised of three distinct groups namely, humic acid, fulvic acid and humin. humic substance increased dry matter production **[2].**

In general, increasing humus level has a number of benefits for plants i.e. increasing water holding capacity and soil warmth via the dark color that absorbs light energy and act as a glue to improve soil aggregation, **[3].** Humic acid improve plant growth through improving soil building and acting in increasing water and roots ability for penetration and permeable in it, Humic acid is considered very important and as media for nutrients to transform soil to plant, increasing soil ability for handling water and induce soil microorganisms activity [4]**.** Also, it is increase reserve of slow release nutrients, solubility of phosphorus to potato plants when it is added at ratio of 1:10 v/v to phosphorus **[5].**

In the same line humic application improved the availability of major and micronutrients viz., iron and zinc, then enhance their uptake, **[6]**. As regard, humic acid increased all growth and yield parameters of potato, but the specific gravity did not affect **[5]** and **[7]** in Pea (*Pisum sativum* L.) **[8]** and in tomato **[6]**. Moreover, **[9]** revealed that eggplant growth was significantly increased with humic application in term of plant height, branches number%, total chlorophyll and mineral content in leaves (N.P.K) and the yield in term of fruit number/plant, fruit weight (gm), plant yield (gm/plant), total yield (ton/hectare).

Fulvic acids are applied on the soil and led to the enhancement of root initiation and increased root growth **[10]**. Fulvic acid application as a soil amendment organic

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materials are source for minerals, energy and water. Certain organisms can also grow on organic substances which are act as growth medium **[11]**. Moreover, humic and fulvic acids are popular in organic farming. The biological activity of humic acid from leonardite is said to be about five times stronger than the humic matter from other sources because of its molecular structure [12]**.**

Vegetables can be potentially exposed to numerous abiotic stresses during production such as drought and high temperatures. Some of these stresses can be resulting production loss, or in quality improvement. Reducing quantities of transpiration by application of anti transpiration is could save considerable quantities of water and also reduce plant stress caused by water deficits. However, in study of the effect of kaolin and Vaporgard on the photosynthesis and water relations of potato plants, it is concluded that by the use of both anti transpiration efficiency and photosynthetic activities increased in plants growth and yield under drought stress **[13].**

Several studies have documented the effect of anti transpiration in horticultural crops. In potatoes under controlled stress conditions, the use of an anti transpiration increased tuber yield **[14]**. Moreover, in onions, an increase of yield was obtained and was attributed to a decreased moisture stress between water applications **[15]**. Also, tomato fruit quality was improved, due to a decrease in fruit cracking **[16]**. On the other hand, reduced transpiration could reduce the uptake of some cations, especially Ca, causing physiological disorders **[17].**

A number of commercially available chemical spray-on products are currently marketed to provide some abiotic stresses protection for various crops. Such products include anti-transpirants, biochemical compounds and plant growth regulators. Anti-transpirants based on their mechanism of action, were divided into three categories, namely film-forming types (which coat leaf surface with films that are impervious to water vapor), reflecting materials (which reflect back a portion of the incident radiation falling on the upper surface of the leaves) and stomatal closing types (which affect the metabolic processes in leaf tissues) **[18].** Early studies demonstrated that the reflective Kaolin improved the water status and the yield of water-stressed tomato plants **[19].**

The apparent high cost of plant water loss may have another benefit besides CO2 absorption – it may affect the acquisition and transport of nutrients by the plant. The mass flow of nutrients such as N, Ca, Mg, and S to root surfaces is attributed to transpiration water uptake by the plant **[20]**. Moreover, **[21]** reported that application of anti transpiration significantly increased stem height, node number, stem diameter, number of pods and number of seeds per plant, thousand seed weight, seed yield, biological yield and harvest index compared with untreated. Also, suggest that using anti transpiration can be effective by reducing the effect of water stress in soybean product.

2. Materials and methods

The field work was carried out at Siwa Research Station of the Desert Research Center, Marsa Matrohe Governorate, during the two consecutive winter seasons of 2013/2014 and 2014/2015. The experiments were conducted to study the effect of soil amendments *i.e.*, humic acid at the rate of 1kg/fed. and fulvic acied at the rate of 1kg/fed. and three commercial anti-transpiration products *i.e.*, phospho X, anti-cool and green miracle as foliar application on growth, yield and chemical composition of eggplant plants, Blake beauty cv. grown in sandy soil conditions. Twenty one treatments were used which were the combination of three soil amendments *i.e.*, humic acied, fulvic acied and control treatment (without application) and seven levels of foliar application *i.e.*, phospho X at the rate of 0.75 and 1.5ml/L, anti cool at the rate of 1 and 2 ml/L, green miracle at the rate of 2.5 and 5 ml/L and control treatment (water). Phospho X consists of 30% P2O5, 4.5% organic nitrogen and 2.5% poly ethylene glycol produced by Union Company for Agricultural Development. Anti cool consists of 12.5% N, 2.5%P, 8.5%K, 0.5%Fe, 2.5% Ca and 5.5%Mg produced by Cera Chima Company. Also, Green miracle consists of 80% fatty alcohol and diluents, 10% neutralizer, 5% emulsifier, 5% stabilizer produced by Stanes Company India, Import by Gahra Company.

The physical and chemical soil characteristics of the studied site were determined according to **[22]** and **[23]** respectively, as recorded in Table (1). The chemical analysis of irrigation water was carried out using the standard method of **[22]** and presented in Table (2).

Table (1). Some physical and chemical properties of the experimental soil site**.**

Depth (cm)		Texture class	pH		E.C. ds m-¹	
0- 25		Sandy loam	6.7		0.58	
Soluble anions (me/l)			Soluble cations (me/l)			
HCO3-	SO4=	Cl-	Ca++	Mg++	Na+	K+
0.75	0.85	4.25	1.15	0.45	3.92	0.33

Table (2). Chemical analysis of the irrigation water**.**

pH		6.7	E.C. ds m-¹		0.58	
Soluble anions (me/l)			Soluble cations (me/l)			
HCO3-	SO4=	Cl-	Ca++	Mg++	Na+	K+
9.35	15.1	39.5	10.1	13.32	39.4	1.17

pH: Acidity E.C.: Electrical conductivity me/l: milli equivalent per liter

Organic manure was added at the rate of 20 m³/fed., while calcium super-phosphate (15.5% P2O5) at the rate of 350 kg /fed., were added during land preparation. Nitrogen fertilizer as ammonium sulphate (20.5% N) and potassium sulphate (48% K2O) at the rate of 350 and 250 kg /fed. respectively, nitrogen and potassium quantities were divided and applied with irrigation during growing season started after 30 days from transplanting. Eggplant seedlings were planted in first week of November through the two growing seasons respectively. Transplanting were sown 50 cm apart on one side of the ridge and irrigated with drip irrigation system. The ridges were 100 cm width among drip irrigation lines and 20m long.

After 20, 40 and 60 days from planting foliar spray *i.e*., Phosphor X at the rate of 0.75 and 1.5ml/L, Anti-cool at the rate of 1 and 2 ml/L and Green miracle at the rate of 2.5 and 5 ml/L were applied, while water was sprayed as a control treatment.

Growth parameters of vegetative growth:

After 100 days from transplanting, three plants of each experimental plot were randomly taken for recording vegetative growth characteristics (*i.e.,* plant height and weight, number of stems/plant and percentage of dry weight of the aerial vegetative parts).

Total chlorophyll in plant laves were measured as SPAD units using Minolta chlorophyll meter (model SPAD 502). Chlorophyll measurements were made using the recently fully expanded leaf and 10 readings were averaged per experimental unit according to **[24].**

Yield and its components:

At fruit ripening stage a sample of three eggplant plants randomly taken from each experimental unit for yield characteristics, *i.e.*, fruit number/ plant, average fruit weight, plant yield and percentage dry matter of fruit were recorded. In addition, total yield (ton/fed.) had been measured.

Chemical components:

Three samples of eggplant fruit from each subplot were taken and dried in oven at 70ºC until stable weight then grinded to fine particles and used to determine chemical contents such as minerals content (K) Potassium were measured using flame photometer method as described by **[25]**. Total nitrogen was determined using the modified micro Kjeldahl method. Phosphorus was determined using the colorimetric method following the procedure described by [**26**]**.** Also, Fe content was determined using Inductively Coupled Argon Plasma, iCAP 6500 Duo, Thermo Scientific, England. 1000 mg/l multi-element certified standard solution, Merck Germany was used as stock solution for instrument standardization.

Anatomical studies

Anatomical studies had been done to show the changes in the structure of the eggplant leaves in response to the different foliar spray treatments. at the flowering stage, the four leaf from top were taken from plant, there after, all samples were cleaned, then cut to suitable parts and immediately killed and fixed in FAA solution. For dehydration, the samples were taken through graded series of ethanol up to absolute concentration followed by series of mixture of chloroform and absolute ethanol up to pure chloroform. Infiltration and embeding were followed by paraffin wax of 54-56C melting point. Cross section of 8 -10 microns in thickness were made at the middle portion of the sample using a rotary microtome. Staining by saffranin light green combination was followed as described by **[27].** the section mounted in canada balsam, air dried examined and microscopically photographed.

Experimental design and statistical analysis:

The experimental treatments were arranged in split plot design with three replicates, the main plots were assigned for soil amendments, whereas, foliar spray rates were randomly arranged in the sub plots. Statistical analyses of obtained data were analyzed according to **[28]**.

3- Results and Discussion

Vegetative growth:

Growth parameters *i.e.,* plant height and weight, No. of stem/plant and shoot dry matter per cent and chlorophyll content were presented in Table (3-5). Obtained results indicated that there are significant positive effects for both soil amendments and foliar spray application on all investigated growth parameters. From the data it could remark the following:

1- The highest values of growth parameters were cleared with humic acid application, no significant differences were found between humic and fulvic acid on No. of stems/plant and chlorophyll content in the first season and on plant height in both seasons. The positive effect of humic acid application may be due to its important role as a soil conditioner to increase water holding capacity and soil warmth (**Piccola et al., 1996).** Moreover**,** improving soil building and acting in increasing water holding and roots ability for penetration and permeable **[4].** Those results in the same line obtained by **[9]** when revealed that the growth of eggplant was significantly increased in term of plant height, branches number%, total chlorophyll with humic acid application.

2- The highest values of plant height and weight recorded with green miracle at the rate of 5m/L in both growing seasons. No significant differences were found between green miracle at the rate of 5m/L and green miracle at the rate 2.5m/L, phosphor X at the rate of 1.5 and anti cool 2m/L. on plant height in the second season only. Moreover, the highest values in number of stems/plant and shoot dry matter were recorded with anti cool at the rate of 2m/L in both growing seasons. Also, all spray treatments surpassed significantly in chlorophyll content when compared with control, but the highest values were recorded with phosphor X at the rate of 1.5m/L in both growing seasons. The positive effect of anti transpiration application may be due to its improve the water status on plants and increased the photosynthetic activities in plants **[19].** The results recorded in Tables (3-4) are in the same line with those obtained by **[21]** reported that application of anti transpiration significantly increased stem height, node number, stem diameter, number of pods in soybean

3-The interaction between two studies factors showed that the high values of No. of stems/plant were recorded with anti cool at the rate of 1m/L with humic application in the first season only and phosph X at the rate of 1.5m/L with humic acid in the second season only.

Table (3): Effect of soil amendments and foliar spray on plant height and weight during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	Plant height (cm)				Plant weight (gm)			
Soil amend.	Fulvic	Humic	Control	X	Fulvic	Humic	Control	X
Spray	acid	acid			acid	acid		
Phospho X 0.75	68.4	62.8	58.5	63.2	469.6	507.9	447.1	474.9
Phospho X 1.5	66.6	67.5	60.1	64.7	497.2	521.9	455.6	491.6
Anti cool 1	64.2	67.5	56.3	62.7	506.2	571.0	485.7	521.0
Anti cool 2	66.8	66.9	62.3	65.3	519.2	578.3	477.5	525.0
Green M 2.5	70.6	73.1	60.0	67.9	531.0	620.5	535.0	562.2
Green M 5	68.7	77.4	63.2	69.8	595.2	666.0	566.8	609.3
Control	65.5	64.0	59.6	63.0	473.2	459.4	451.4	461.3
X	67.3	68.5	60.0		513.1	560.7	488.4	
Season				2014/2015				
Phospho X 0.75	69.7	66.7	58.4	64.9	519.5	574.0	467.1	520.2
Phospho X 1.5	72.0	72.2	61.0	68.4	559.9	601.4	488.3	549.9
Anti cool 1	67.5	69.8	60.4	65.9	571.1	642.6	506.9	573.5
Anti cool 2	70.0	69.8	62.2	67.3	568.9	643.0	483.3	565.1
Green M 2.5	71.3	77.8	62.7	70.6	567.1	682.1	619.4	622.9
Green M 5	66.9	79.7	65.8	70.8	634.5	728.8	614.1	659.1
Control	65.4	67.1	63.5	65.3	499.9	493.5	499.0	497.5
X	69.0	71.9	62.0		560.1	623.6	525.4	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	2.19			3.33	28.2			41.7
spray	4.38			3.92	30.2			30.0
Soil X spray	NS			NS	NS			59.9

Table (4): Effect of soil amendments and foliar spray on number of stems/plant and dry matter of shoot (%) during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	number of stems/plant				dry matter of shoot (%)			
Soil amend.	Fulvic	Humic	Control	X	Fulvic	Humic	Control	X
Spray	acid	acid			acid	acid		
Phospho X 0.75	7.67	9.00	7.33	8.00	17.6	19.2	17.0	17.9
Phospho X 1.5	6.67	13.33	8.33	9.44	18.3	18.7	17.9	18.3
Anti cool 1	8.67	14.3	6.67	9.89	18.5	18.5	19.1	18.7
Anti cool 2	10.3	12.3	8.67	10.4	20.5	18.8	20.4	19.9
Green M 2.5	9.67	8.67	7.67	8.67	19.3	18.8	18.8	19.0
Green M 5	11.6	9.33	8.67	9.89	19.9	18.3	19.4	19.2
Control	11.00	10.00	5.33	8.78	19.5	19.5	19.4	19.5
X	9.38	11.00	7.52		19.1	18.8	18.9	
Season				2014/2015				
Phospho X 0.75	8.73	8.76	6.21	7.90	19.1	20.9	18.5	19.5
Phospho X 1.5	6.52	15.97	9.31	10.6	19.3	21.3	18.7	19.8
Anti cool 1	9.27	15.44	6.73	10.5	20.6	21.0	19.7	20.4
Anti cool 2	11.4	12.42	8.80	10.8	21.7	21.0	20.6	21.1
Green M 2.5	10.5	9.71	8.72	9.64	19.8	21.1	20.3	20.4
Green M 5	11.4	10.79	8.19	10.1	21.3	19.2	20.8	20.4
Control	11.87	11.33	6.01	9.73	19.5	21.5	20.7	20.6
X	9.95	12.06	7.71		20.2	20.9	19.9	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	1.68			1.55	NS			NS
spray	1.48			1.10	1.13			0.66
Soil X spray	2.97			2.20	NS			1.32

Yield and its components

Yield parameters i.e., fruits number/ plant and weight, fruit dry matter plant yield and total yield/fed. were presented in Table (5-7). Obtained results indicated that there are significant positive effects for both soil amendments and spray application on all investigated yield parameters. From the data it could remark the following.

The highest values of yield parameters were cleared with humic acid application, no significant differences were found between humic and falvic acid on all yield

parameters, except fruit dry matter increased significantly with control treatment in both seasons. The positive effect of humic acid application may be due to its important role as a soil conditioner to increase water holding capacity and soil warmth induce soil microorganisms activity, these results are agree with those obtained by **[5] and [7]** on potato and **[8]** in Peas (*Pisum sativum* ***L.*****)** and in tomato **[6]** and **[9]** on eggplant.

Green miracle at the rates of 2.5 and 5 ml/l has significant positive effect on fruits number and weight, plant yield and total yield in both growing seasons. The positive effect of anti transpiration application may be due to it's improve the water status on plants and photosynthetic activities **[19].** Moreover, the use of an anti transpiration increased tuber yield **[14].** In onions, an increase of yield was attributed to a decrease of moisture stress in water application **[15]** Also, fruit quality of tomato was improved due to a decrease in fruit cracking **[16]** as a reflect of anti-transpiration application.

The interaction between two studies factors showed that fulvic acid amendment combined with spray application by green miracle at the rates of 2.5m/L and 5m/l recorded the highest values of plant yield and total yield respectively in the second season only and on fruit weight in both seasons.

Chemical composition:

It is cleared from Tables (8&9) that humic acid application at the rate of 1 Kg/fed. led to increase significant in N (%) in eggplant fruits through both seasons and in Fe content in the second season only. Moreover, control treatment showed the highest value in Fe (ppm) in the first season only. The positive effect of humic acid application may be due to its considered very important and as media for nutrients from soil to plant, increasing soil ability for handling water and induce soil microorganisms activity. Also, it is increased reserve of slow release nutrients, solubility of phosphorus to plant**.** In the same line humic application improved the availability of major and micronutrients *viz.*, iron and zinc and enhance their uptake. These results agreed with those obtained by (**[4], [5] and [6].**

Phospho X treatment when applied at the rate of 1.5 m/L gave significant surpasses in P (%) and Fe (ppm) content of eggplant fruits when compared with control treatments through both growing seasons, no significant differences were found between both phospho x rates in P (%) content. The positive effect of anti transpiration may be due to its affect the acquisition and transport of nutrients by the plant. The mass flow of nutrients such as N, Ca, Mg, and S to root surface is attributed to transpiration water uptake by the plant **[20]**.

The interaction of both studies factors showed that fulvic acid combined with Phospho X at the rate of 1.5 m/L gave significant increase in Fe (ppm) content in both growing seasons.

Anatomical studies

Anatomy of leaves parameters i.e., Leaf thick (µ), Palisade length (µ), Spongy length (µ), Cell width (µ), Cell area (µ ²) and No. of air space were presented in Table (10) and Fig.(1). Obtained results indicated that there were effected for both soil amendments and spray application on all investigated leaves anatomy parameters. From the data it could remark the following

1- The highest values of Leaf thick (µ), Palisade length (µ) and Cell area (µ ²) were recorded with falvic and humic acid amendments compared with control treatment. On the other hand, control treatment increased Palisade cell width and No. of air space. A thinner leaf blade resulting from smaller palisade parenchyma cells Fig (1) and a reduction in the number and size of the spongy parenchyma cells and increased in the number of air space also represents the main anatomical changes observed in control treatment plants the enhancement in leaves anatomy as effected by soil amendments may be due to soil amendments had prominent role in enhancing plant growth, some osmoprotectants and nutritional status. It could also play an indirect role in various physiological processes, including cell division and expansion, xylem differentiation and stem elongation. Disturbances in cell division and elongation could occur due to disturbances in plant water relations and mineral nutrition and also slowing down of basic metabolic processes **[29].**

2- All spray application treatments sowed positive effect on leaves anatomy compared with control treatment. Green miracle at rate of 5ml/l showed the highest increment of Leaf thick (µ), Palisade length (µ) and Cell area (µ ²) by 60%, 14.6 and 167.8 % respectively, compared with control treatment. From fig (1) showed that in all spray treatments except phospho X at the rate of 0.75ml/l increased in Palisade call length (µ) and numbers it was crammed cells compressed. Also, on the other hand control treatment increased on the number of air space between Spongy cells. Palisade parenchyma cells contain chloroplasts. The function of palisade parenchyma is photosynthesis. The enhancements in leaves anatomy that affected by spray application may be due to increased mineral content in leaves cells and water status on plants which increased cell division of palisade parenchyma cells which increased photosynthesis and reflect on growth and yield **[19]**.

Table (5): Effect of soil amendments and foliar spray on chlorophyll and dry matter of fruit during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	Chlorophyll				Dry matter of fruit (%)			
Soil amend.	Fulvic	Humic	Control	X	Fulvic	Humic	Control	X
Spray	acid	acid			acid	acid		
Phospho X 0.75	54.0	63.9	53.9	57.3	8.24	8.42	8.77	8.48
Phospho X 1.5	63.3	64.0	58.0	61.8	8.49	7.77	8.90	8.39
Anti cool 1	52.2	57.4	54.3	54.7	7.48	8.36	8.79	8.21
Anti cool 2	55.4	56.4	53.4	55.1	7.73	8.46	7.96	8.05
Green M 2.5	54.0	53.7	48.5	52.0	7.20	8.30	8.60	8.04
Green M 5	53.3	56.5	50.4	53.4	7.94	8.29	8.39	8.21
Control	48.3	51.7	45.1	48.4	9.43	8.19	9.52	9.05
X	54.4	57.7	51.9		8.07	8.26	8.70	
Season				2014/2015				
Phospho X 0.75	57.7	59.8	60.4	59.3	9.00	8.97	8.79	8.92
Phospho X 1.5	58.0	67.5	57.0	60.9	8.75	7.66	9.29	8.57
Anti cool 1	59.9	62.2	54.4	58.8	7.58	8.67	8.80	8.35
Anti cool 2	59.8	65.2	53.8	59.6	8.64	8.62	8.27	8.51
Green M 2.5	58.4	58.7	58.8	58.6	7.30	8.79	9.64	8.58
Green M 5	55.9	60.4	61.4	59.2	7.93	8.93	8.72	8.53
Control	56.3	57.0	52.6	55.3	9.09	9.17	9.75	9.33
X	58.0	61.5	56.9		8.33	8.69	9.04	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	3.69			1.05	0.36			0.27
spray	2.97			2.96	0.60			0.49
Soil X spray	NS			5.91	NS			0.99

Table (6): Effect of soil amendments and foliar spray on fruit number and weight during growing seasons 2013/2014 and 2014/2015**.**

Season	2013/2014							
Characters	Fruit number				Fruit weight (gm)			
Soil amend.	Fulvic	Humic	Control	X	Fulvic	Humic	Control	X
Spray	acid	acid			acid	acid		
Phospho X 0.75	14.1	14.8	13.3	14.0	181.3	187.2	166.0	178.1
Phospho X 1.5	13.9	14.3	13.7	14.0	186.3	193.2	160.5	180.0
Anti cool 1	14.7	14.8	13.9	14.5	207.2	216.0	181.6	201.6
Anti cool 2	15.0	16.1	14.8	15.3	184.8	203.0	207.2	198.3
Green M 2.5	15.3	15.7	15.0	15.3	248.5	198.3	192.8	213.2
Green M 5	15.9	16.2	15.3	15.8	248.8	218.6	202.8	223.4
Control	13.8	14.4	13.6	14.0	151.6	190.5	148.6	163.5
X	14.7	15.2	14.2		201.2	201.0	179.9	
Season				2014/2015				
Phospho X 0.75	16.2	16.2	16.0	16.1	202.8	202.1	177.0	194.0
Phospho X 1.5	15.9	16.7	15.7	16.1	208.3	214.2	173.0	198.5
Anti cool 1	17.2	17.2	16.4	16.9	217.3	238.4	185.0	213.6
Anti cool 2	17.0	18.2	16.9	17.3	177.6	198.4	201.4	192.5
Green M 2.5	17.9	17.9	17.2	17.7	259.6	226.4	224.5	236.9
Green M 5	18.0	18.5	17.3	17.9	254.0	239.5	229.0	240.8
Control	16.2	17.0	16.2	16.5	167.9	209.1	162.4	179.8
X	16.92	17.38	16.54		212.52	218.32	193.19	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	0.69			0.57	10.8			15.4
spray	0.67			0.37	16.6			13.9
Soil X spray	NS			NS	33.1			27.8

Table (7): Effect of soil amendments and foliar spray on plant yield and total yield during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	Plant yield (kg)				Total yield (ton/fed.)			
Soil amend. / Spray	Fulvic acid	Humic acid	Control	X	Fulvic acid	Humic acid	Control	X
Phospho X 0.75	2.55	2.77	2.20	2.51	14.03	15.23	12.12	13.79
Phospho X 1.5	2.59	2.76	2.19	2.51	14.23	15.19	12.06	13.83
Anti cool 1	3.05	3.19	2.53	2.92	16.79	17.53	13.90	16.07
Anti cool 2	2.79	3.28	3.07	3.05	15.37	18.05	16.89	16.77
Green M 2.5	3.79	3.13	2.90	3.27	20.87	17.19	15.93	18.00
Green M 5	3.95	3.54	3.09	3.53	21.71	19.48	17.02	19.41
Control	2.10	2.75	2.03	2.29	11.56	15.11	11.14	12.60
X	2.98	3.06	2.57		16.37	16.83	14.15	
Season				2014/2015				
Phospho X 0.75	3.29	3.27	2.84	3.13	18.08	17.99	15.62	17.23
Phospho X 1.5	3.32	3.58	2.71	3.21	18.26	19.70	14.92	17.63
Anti cool 1	3.74	4.09	3.04	3.63	20.59	22.50	16.73	19.94
Anti cool 2	3.02	3.61	3.40	3.34	16.58	19.87	18.70	18.39
Green M 2.5	4.65	4.06	3.86	4.19	24.57	22.31	21.21	22.70
Green M 5	4.57	4.43	3.96	4.32	25.15	24.34	21.81	23.76
Control	2.73	3.55	2.64	2.97	15.01	19.51	14.51	16.34
X	3.62	3.80	3.21		19.75	20.89	17.64	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	0.25			0.25	1.39			1.04
spray	0.32			0.25	1.76			1.37
Soil X spray	NS			0.51	NS			2.75

Table (8): Effect of soil amendments and foliar spray on nitrogen and phosphorus during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	N (%)				P (%)			
Soil amend. / Spray	Fulvic acid	Humic acid	Control	X	Fulvic acid	Humic acid	Control	X
Phospho X 0.75	6.47	7.46	6.43	6.79	0.81	0.73	0.77	0.77
Phospho X 1.5	5.77	6.56	5.84	6.06	0.88	0.82	0.82	0.84
Anti cool 1	4.91	7.25	6.64	6.27	0.64	0.56	0.58	0.59
Anti cool 2	6.44	6.30	6.71	6.48	0.59	0.56	0.64	0.60
Green M 2.5	5.90	7.53	5.44	6.29	0.53	0.57	0.53	0.54
Green M 5	7.24	7.46	5.74	6.81	0.58	0.57	0.53	0.56
Control	6.75	6.62	5.65	6.34	0.56	0.52	0.57	0.55
X	6.21	7.02	6.07		0.66	0.62	0.63	
Season				2014/2015				
Phospho X 0.75	6.85	7.71	7.23	7.26	0.83	0.84	0.84	0.84
Phospho X 1.5	6.12	7.73	5.53	6.46	0.90	0.82	0.88	0.87
Anti cool 1	5.41	7.94	7.03	6.79	0.65	0.68	0.67	0.67
Anti cool 2	7.86	7.33	7.61	7.60	0.61	0.56	0.61	0.59
Green M 2.5	6.32	7.59	5.82	6.58	0.60	0.61	0.51	0.58
Green M 5	7.14	7.67	5.90	6.91	0.55	0.67	0.62	0.61
Control	6.64	6.49	6.18	6.44	0.63	0.58	0.63	0.61
X	6.62	7.50	6.47		0.68	0.68	0.68	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	0.34			0.48	NS			NS
spray	NS			NS	0.09			0.06
Soil X spray	NS			NS	NS			NS

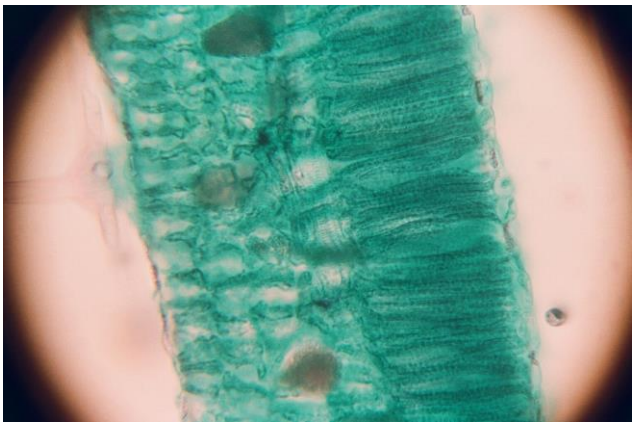
Table (9): Effect of soil amendments and foliar spray on K and Fe during growing seasons 2013/2014 and 2014/2015.

Season	2013/2014							
Characters	K (ppm)				Fe (ppm)			
Soil amend. / Spray	Fulvic acid	Humic acid	Control	X	Fulvic acid	Humic acid	Control	X
Phospho X 0.75	65.4	73.2	67.6	68.7	12.9	12.8	14.1	13.3
Phospho X 1.5	70.6	67.6	69.9	69.4	16.0	12.3	14.6	14.3
Anti cool 1	68.6	70.1	69.1	69.3	11.9	14.1	13.3	13.1
Anti cool 2	70.1	70.5	71.3	70.6	12.6	14.5	13.4	13.5
Green M 2.5	71.8	68.8	67.9	69.5	12.4	13.5	13.7	13.2
Green M 5	68.2	69.5	68.8	68.8	12.2	13.5	13.3	13.0
Control	66.5	67.6	68.4	67.5	12.0	13.4	13.3	12.9
X	68.7	69.6	69.0		12.8	13.4	13.7	
Season				2014/2015				
Phospho X 0.75	66.7	70.9	72.4	70.0	13.2	14.1	14.1	13.8
Phospho X 1.5	72.0	74.1	76.6	74.3	16.3	14.1	15.5	15.3
Anti cool 1	66.6	75.2	70.3	70.7	12.1	14.9	13.8	13.6
Anti cool 2	72.9	76.8	72.2	74.0	13.1	16.3	13.9	14.4
Green M 2.5	73.4	73.0	78.8	75.0	12.9	13.6	14.9	13.8
Green M 5	70.4	78.8	72.2	73.8	12.8	14.2	14.4	13.8
Control	68.1	71.1	72.9	70.7	13.1	14.0	14.4	13.8
X	70.0	74.3	73.6		13.4	14.5	14.4	
L.S.D at 0.05	Sea(1)			Sea(2)	Sea(1)			Sea(2)
Soil amend.	NS			NS	0.53			0.67
spray	NS			NS	0.87			0.78
Soil X spray	NS			NS	1.74			1.55

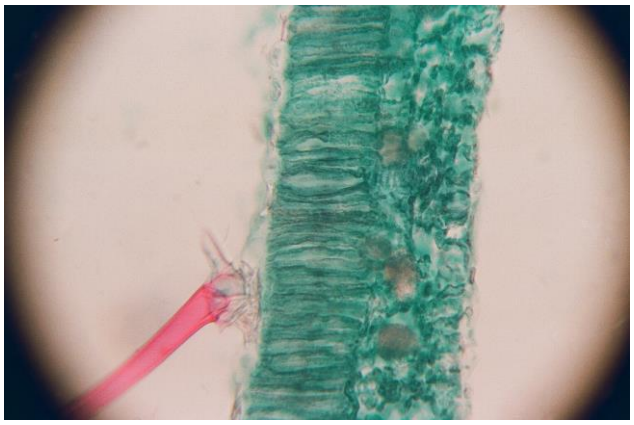
Table (10): Effect of soil amendments and foliar spray on leaf thick, palisade length, spongy length, palisade cell width, cell area and No. of air space.

Characters	Leaf thick (µ)				Palisade length (µ)			
Soil amend. / Spray	Fulvic acid	Humic acid	Control	X	Fulvic acid	Humic acid	Control	X
Phospho X 0.75	255	195	180	210	150	105	90	115
Phospho X 1.5	255	210	225	230	165	105	120	130
Anti cool 1	225	270	210	235	135	120	120	125
Anti cool 2	210	225	270	235	120	150	150	140
Green M 2.5	240	285	240	255	150	135	135	140
Green M 5	270	270	255	265	165	165	150	160
Control	180	150	165	165	75	60	60	65
X	233.6	229.3	220.7		137.1	120.0	117.9	
	Spongy length (µ)				Palisade Cell width (µ)			
Phospho X 0.75	105	90	90	95	6	9	15	10
Phospho X 1.5	90	105	105	100	15	12	13.5	14
Anti cool 1	90	150	90	110	15	10.5	13.5	13
Anti cool 2	90	75	120	95	15	9	12	12
Green M 2.5	90	150	105	115	13.5	12	15	14
Green M 5	105	105	105	105	13.5	10.5	15	13
Control	105	90	105	100	10.5	12	13.5	12
X	96.4	109.3	102.9		12.6	10.7	13.9	
	Cell area (µ ^{2})				No. of air space			
Phospho X 0.75	707.1	1060.7	742.5	837	5	4	6	5
Phospho X 1.5	1944.6	1272.9	990	1403	6	5	4	5
Anti cool 1	1591.1	1272.9	990	1285	3	3	7	4
Anti cool 2	1414.3	1414.3	1060.7	1296	4	5	6	5
Green M 2.5	1591.1	1591.1	1272.9	1485	3	3	4	3
Green M 5	1750.2	1767.9	1361.3	1626	4	2	4	3
Control	618.8	636.4	565.7	607	11	10	13	11
	1373.9	1288	997.59		5.1	4.57	6.29	

Fig. (1): Effect of soil amendments and foliar spray on leaf thick, palisade length, spongy length, palisade cell width, cell area and No. of air space**.**



Fulvic acid X (Phosphor X 1.5 ml/l)



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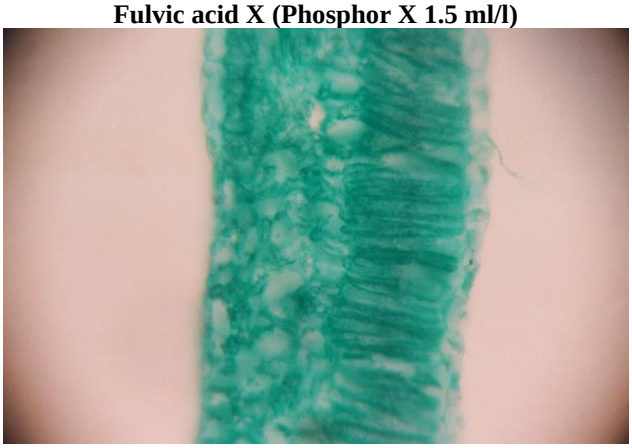

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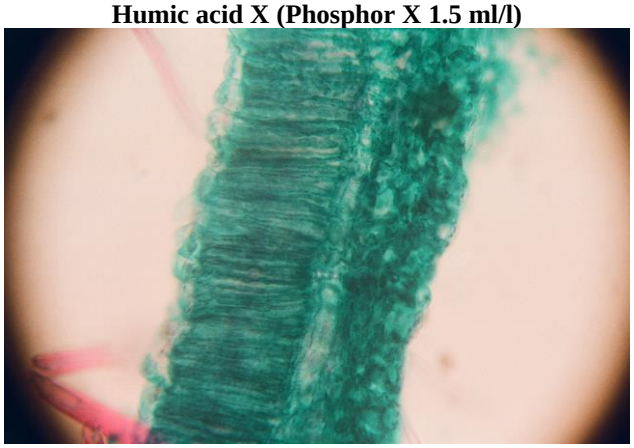

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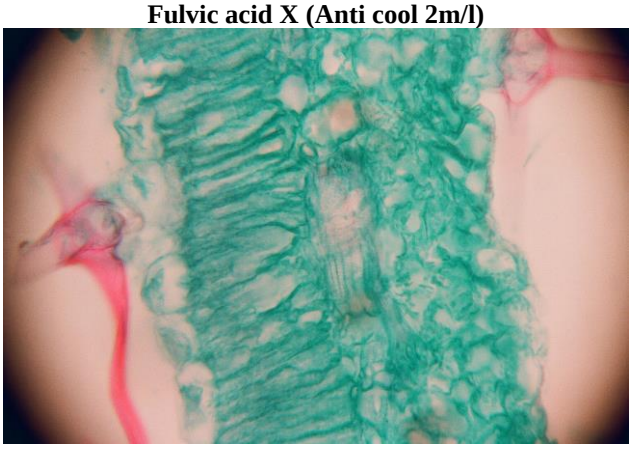
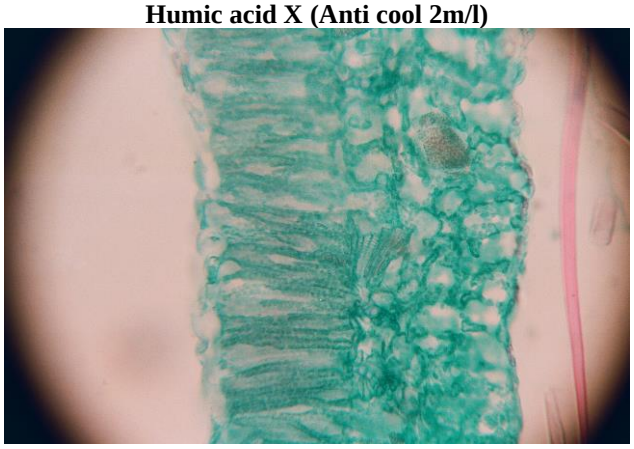


Fulvic acid X (Green m.5ml/l)



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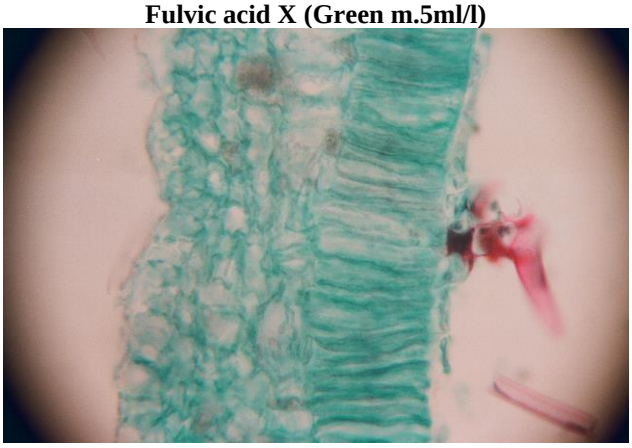
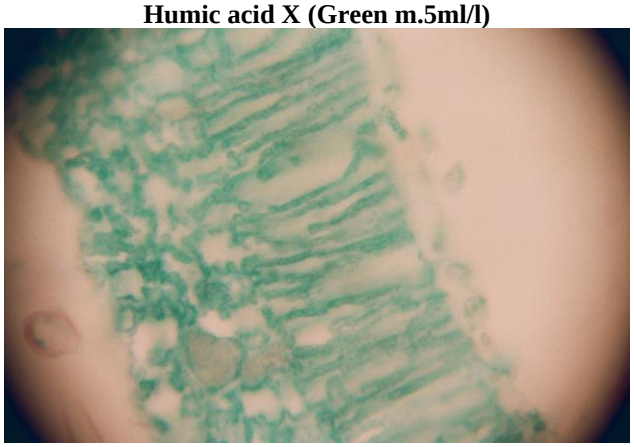


Control X (Green m.5ml/l)



Control

Reference

[1] Al-Gumer M.K., K.B. Esho and H. Putrus. Performance evaluation and yield correlation and its components of eight eggplant cultivars, Al-Rafidain Agric. J. 25:11-15.1993

[2] Singaroval, R., Balasubramanian T.N. and R. Govindasamy. Effect of humic on sesam (*Sesamum indicum*) Indian J.Agron., 38: 147-149. 1993

[3] Piccolo A., Pietramellara G. and J.S.C. Mbagwu. Effects of coal derived humic substances on water retention and structural stability of Mediterranean soils. Soil Use and Management Vol. 12, Issue 4, p. 209–213. 1996

[4] Phelpstek. Structure, Properties, and Soil Application, Fage 30 fg, available online at: http://www.com/clients/humic acid.html. 2002

[5] Hopkins, b. and J. Stark. Humic acid effects on potato response to phosphorus. Idaho Potato Conference. Jan. 22-23. 2003

[6] Tenshia J.S. and P. Singaram. Influence of humic acid on yield, nutrient availability and uptake by tomato. The Madras Agriculture Journal,92:10-12, 670-676. 2005

[7] Sarhan T. Z. Effect of humic acid and sea weed extracts on growth and yield of potato (*Solanum tubersum* L) Desiree CV. Mesopotamia j. of Agric Vol. (39) No (2). 2011

[8] Gad El-Hak, S.H., Ahmed A.M. and Y.M.M. Moustafa. Effect of foliar application with two antioxidants and humic acid on growth, yield and yield components of Peas (*Pisum sativum L.*) J. of horticultural Sci. & Ornamental Plants. 4 (3): 318-328. 2012

[9] Sarhan T. Z., G. H. Mohammad and J. A. Teli. Effects of Humic Acid and Bread Yeast on Growth and Yield of Eggplant (*Solanum melongena* L.). J. of Agric. Sci. and Techn. 1091-1096. 2011

[10] Pettit R.E. Organic matter, humus, humate, humic acid, fulvic acid and humin: Their importance in soil fertility and plant health [Online]. Available at www.humate.info/mainpage.htm. 2004

[11] Zimmer, G. Humates and humic Substances, Bio-Correct inputs for the eco-farmer. ACRES (USA) a voice for eco-agriculture. 34: 1. 2004

[12] Anonymous. Humic and fulvic acids: The black gold of agriculture. www.humintech.com/pdf/humicfulvic acids.pdf. 2010

[13] Muzzarelli, R.A.A. Chitin. Pergamon Press, Oxford. 1977

[14] Byari, S. H., and R. B. O'Keefe. Effect of anti transpirants on heat and drought response of potato varieties. Hort. Sci. 17: 513–518. 1982

[15] Lipe, W. N., K. Hondnet, M. Gerst, and C. W. Wendt. Effects of anti- transpirants on water use and yield of greenhouse and field grown onion. Hort. Sci.17: 242–244. 1982

[16] Phelps E., and T. Morelock. Antitranspirants as a selection technique in breeding for tomato fruit cracking resistance. HortScience 22: 728– 733. 1987

[17] Morley, P. S., M. Hardgrave, M. Bradley, and D. J. Pilbeam. Susceptibility of sweet pepper (*Capsicum annuum* L.) cultivars in the calcium deficiency disorder 'blossom-end rot'. In: Optimization of Plant Nutrition, eds. M. A. C., Fragoso and M. L. Van Beusichem, pp. 561–567. 1993.The Netherlands: Kluwer.

[18] Prakash M., and K. Ramachandran "Effects of Chemical Ameliorants in Brinjal (Solanum melongenaL.) under Moisture Stress Conditions." J. of Agron. Crop Sci., , 185 : 237-239. 2000

[19] Glenn D. M., Erez A., Puterka G. J. and P. Gundrum Particle films affect carbon assimilation and yield in 'Empire' apple. –J. Amer. Soc. Hort. Sci. 128: 356–362. 2003

[20] Havlin, J. L., J. D. Beaton, S. L. Tisdale, and W. L. Nelson. Soil Fertility and Fertilizers: An Introduction to Nutrient Management. 7th Ed. Prentice Hall, Upper Saddle River, NJ. 2005

[21] Javan M. Tajbakhsh M. and A. Babak. Effect of antitranspirants application on yield and yield components in soybean (Glycine max L.) under limited irrigation. Journal of Applied Biological Sciences 7 (1): 70-74. 2012

[22] Page, A. L., Miller R. H. and D. R. Keeney. Methods of soil analysis. No. (9), Part 2. Chemical and Microbiological Properties. Am. Soc., Agron., Inc. Soil. Sci., Mad., Wisc., U.S.A. 1982

[23] Klute, A. J. (1986). Methods of soil analysis. No. (9), Part 1 - Physical and Mineralogical Methods. Am. Soc., Agron., Inc. Soil. Sci., Mad., Wisc., U.S.A.

[24] A.O.A.C. Official Methods of Analysis. Twelfth ed. Published by the association of official analytical chemists. Benjamin. Frank line station, Washington. Dc. 1990

[25] Brown, J.D. and O. Lilliland. Rapid determination of potassium and sodium in plant material and soil extracts by flame photometer. Proc. Amer.Soc. Hort. Sci., 48: 341-346. 1964

[26] Cottenie, A.; Verloo M.; Kickens L.; Velghe G. and Camerlynck, R. Chemical analysis of plants and soils. Laboratory of Analytical and Agrochemistry. State Univ., Ghent Belgium, pp: 63. 1982

[27]Johansen, D. A. Plant microtechnique. Mc. Grow – Hill Book Company. New-york, London. Pp:523. 1940

[28] Thomas, M. L. and F. G. Hills. Statistical Methods In Agric. Research, Univ. of California, Davis 95616 2nd printing, pp. 67-74. 1975

[29] Seregin, I.V. and V.B. Ivanov. Physiological aspects of cadmium and lead toxic effects on higher plants. Rus J Plant Physiol 48: 523–544. 2001