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Using some Compounds to Alleviate Salinity Stress on Sweet Pepper Plants.

El- Afifi, S. T. M.[1]; M. M. Zaghloul[1]; El-S. L. S. Fathy[2] and M. S. Wahba[2]
[1] Veg. and Flori. Dept., Fac. of Agric., Mans. Univ., Egypt.
[2] Veg. Res. Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Two field experiments were conducted at Private Farm Al-Doaa region, Baltim, Kafr Ash Shaykh, Egypt in 2015, 2016 seasons to study the effect of some osmo-regulators and/or antioxidants to ameliorate the harmful effects of salinity stress on Top Star hybrid sweet pepper (*Capsicum annuum,* L) plants in sandy soil under drip irrigation system, during the early summer season on vegetative growth, fruit yield and quality.The obtained results could be summarized as follows:Soil application of Kitasal (2 ml/l) gave the longest plant, heaviest fresh and dry weight, largest leaf area, and gave the highest fruit yield (ton/fed.) compared with other treatments in both seasons. All foliar applications significantly increased all studied parameters compared with the untreated plants. The superior application was 250 ppm glycine-betaine followed by Glutathione (50 ppm) or Potassium silicate (250 ppm) in both seasons, respectively. Interaction between soil application of Kitasal (2 ml/l) and foliar application of glycine-betaine (250 ppm) gave the highest values of vegetative growth represented by plant height, leaf area fresh and dry weight along with, fruit yield and its component represented by fruit weight, yield/plant, and total yield/fed. From the obtained results it could be concluded that, using Kitasal (2ml/l) as soil application in combination with foliar application of 250 ppm glycine-betaine improved both growth and yield of sweet pepper plants under salinity condition.

Keywords: Capsicum annuum, Salinity, Potassium Silicate, Salicylic Acid, Glutathione, Glycine-betaine.

INTRODUCTION

Sweet pepper (Capsicum annuum ,L) is known as a favorite and widespread vegetable crop over the world, its fruit rich in antioxidants, vitamins and minerals for human diet and healthy(Mateos *et al*., 2003).

One of the most important abiotic stresses is salinity in soil or water (Tables: 1 and 2) hence, it is reported that more than 6% of land area of the world is affected by salinity stress. The main causes of salinity problem in agricultural areas are wrong management of soil and water, low rainfall and high evaporation. (Arzani, 2008).

It is well known that pepper plants are classified sensitive to moderately sensitive to salt stress (Lee, 2006), witch severely inhibits plant growth and yield (Paridam and Das, 2005) for two reasons, first by an osmotic or water- deficit effect of salinity and second by a salt-specific or ion excess effect of NaCl. Moreover, plants subject to salinity stress conditions produce cytotoxic activated oxygen that can seriously disrupt normal metabolism, through oxidative damage of lipids, proteins, and nucleic acids (Abbaspour, 2012).

Soil application by salinity curing compounds is a good tool for alleviating the harmful effects of salinity and improving productivity and quality of sweet pepper plants. In this direction, Kitasal plays a dual role in alleviating salinity stress since, it contains Calcium that ameliorates the effect of salt stress by competing with sodium ions for membrane-binding sites, play an important role in processes that preserve the structural and functional integrity of plant membranes, regulate ion transport and control activities of cell wall enzymes (Rengel, 1992) accompanied with poly hydro carboxylic acids that has a fundamental role in reducing the adverse effect of salt stress in all growth parameters and this belongs to its structure, especially for organic matter and organic acids which act as balance of charges formed during the extensive metabolism of anions such as nitrate (NO3) and in modulating adaptation to the environment (Jasim *et al*. 2015).

Potassium silicate acts as an ameliorative agent due to its role in decreasing the negative effects of sodium chloride (NaCl) where potassium ions compete with sodium ions in the root zone (Chen *et al*., 2007), silicate has been shown to mitigate adverse effects of water, mineral deficiency (Ma *et al*., 2001) and alleviate the effects of biotic stresses including salt stress, metal toxicity and nutrient imbalance (Ma, 2004).

Salicylic acid is a signaling or messenger molecule in plants and induces plant tolerance against various biotic and abiotic stresses (Horvath *et al*., 2007). Glutathione is a strong antioxidant which prevents damage to important cellular components caused by ROS (Pompella *et al*., 2003).

Glycine betaine is very common to be accumulated during salt stress and play a fundamental role in osmotic adjustment in plants (Szabados and Savoure, 2010).

Citric acid plays an essential role in signal transduction system, membrane stability and functions, activating transporter enzymes, metabolism and translocation of carbohydrates. In addition, it consider as one of non-enzymatic antioxidants which act to eliminate free radicals produced in plants under stress (Yan-Lin and Soon 2001).

Amino acids (Vegetamin) are directly or indirectly involved in the regulation of plant responses to environmental signals related to abiotic or biotic stress (Ashraf and Harris, 2004).

The present work is an attempt to evaluate the effects of some osmo-regulators and/or antioxidants to ameliorate the harmful effects of salinity stress on sweet pepper plants in sandy soil under drip irrigation system, under the conditions of Baltim, Kafr Ash Shaykh, Egypt in both seasons of study.

MATERIALS AND METHODS

Two successive experiments were conducted at Al-Doaa region, Baltim, Kafr Ash Shaykh, Egypt in 2015, 2016 seasons to study the effect of osmo-regulators i.e. (Glycine-betaine and Vegtamin) and/or antioxidants i.e. (Salicylic acid, Glutathione and Citric acid) for ameliorating the harmful effects of salinity stress on Top Star hybrid sweet pepper (Capsicum annuum L) plants in sandy soil under drip irrigation system, during the early summer season.

Table 1. Physical and chemical analysis of the experimental soil.

Properties	Value	Properties	Value
Physical		Soluble anions (meq/100g soil)	
Soil texture	Sandy soil	HCO_3^-	0.40
Organic matter %	0.4	CL^-	1.33
Chemical		SO_4^{--}	4.23
E.C. (mmohs/cm)	2.15	Macro-elements (ppm)	
pH	7.38	N	61 ppm
		P	15 ppm
		K	130 ppm

The physical and chemical analyses of the experimental soil shown in Table (1) and chemical analysis of irrigation water shown in table (2).

Table 2. irrigation Water analysis (ppm)

EC	1.57
carbonate	0.0
bicarbonate	270.84
chloride	266.96
sulphate	179.52
Calcium	17.6
Magnesium	4.8
Sodium	328.42
Potasium	5.5
N: 6.93 (ppm) P: 0.0952 (ppm) K: 9 (ppm) PH 7.45	

Experimental design:

Split plot design with three replications was adopted; main plots as soil application and sub plots as foliar applications.

Experimental treatments:

Soil application of Kitasal (0, 1 and 2 ml/L) commercial compound produced by JISA Company, Spain and imported by Pharmaceutica Company, Egypt contains: 9.30% w/w calcium oxide, poly-hydrocarboxylic acids 17.50% w/w and calcium complexed with lignosulphonic acid.

Foliar applications (Potassium Silicate (200 ppm), Salicylic Acid (250), Glutathione (50 ppm), Glycine-betaine (250 ppm), Citric Acid (2000 ppm), Vegetamin (2ml/L), commercial compound produced by JISA Company, Spain and imported by Pharmaceutica Company, Egypt contains: free amino acids 20.0% w/w (Alanine, Aspartic, Glutamate, Glycine, Isoleucine, Leucine, Lysine, Phenylalanine, Proline, Serine,Threonine, Valine), total Nitrogen 5.5 % w/w, organic Carbon 13.9% w/w and organic matter 24.0% w/w. , Mix application as half concentration of each foliar treatment and control.

The plants were applied with treatments 4 times, the first application 30 days after transplanting with 10 days intervals.

Data recorded:

Vegetative growth:

After 75 days from transplanting five plants were randomly taken from each plot for determining the following data:

Plant height,(cm/plant), fresh weight (gm/plant) and dry weight (gm/plant). Total leaf area (m2), total fresh weight includes tip parts and root and dry weight (g/plant).

b. Yield and its components:

Fruits of each plot were harvested at the proper maturing stage, counted and weighted in each harvest and the following parameters were collected:

Number of fruits, fruit length, flesh thickness, average weight of fruit (gm) and total yield (ton/fed.).

Statistical analysis:

All data were statistically analyzed based on ANOVA and Duncan's Multiple Range Test of means by using Costat statistical software (V. 6.311 CoHort Software).

RESULTS AND DISCUSSION

Vegetative growth characters:

Effect of soil application:

Data presented in Table (3) showed that using Kitasal as soil application at concentration 2ml/l ameliorated the adverse effects of salinity stress and showed the highest values than other treatments in all vegettive growth characters, i.e., plant height ,Leaf area and fresh and dry weight followed by the concentration of 1ml/l in both seasons .

Similar results were obtained by Fenn and Taylor, (1990); Fenn *et al*., (1991) on tomato plants and sugar beet, El-Tohamy *et al*., (2006) on pepper plants and Jasim *et al*. (2015) on salt stressed squash.

Effect of foliar application:

Data in Table (3) indicated that glycine-betaine gave the highest improvements in plant height ,leaf area , fresh and dry weights followed by glutathione then potassium silicate, in addition all applied treatments showed a significant improvements in all studied growth parameters compared with the untreated ones in both seasons .These results were agreed with those of Sanaa *et al*. (2013) using glycine-betaine on cotton plants and Rezaei *et al*.(2012) on salt stressed soybean plants .

In addition, Manivannan *et al*. (2016) stated that, potassium silicate had a positive effect on growth of pepper plants and alleviated the deletrious effects of salt stress.

Effect of interactions:

Data in Tables (4) indicated that, the effect of all interactions were significantly improved plant height in the two seasons,fresh weight and dry weight as well as leaf area.

In general, kitasal at2 ml/l combined with glycine-betaine, glutathione flowed by potassium silicate or salicylic acid gave the best interaction results in all studied growth parameters during the two seasons respectively. While, the lowest one was kitasal at 0 or

1ml with vegetamin flowed by citric acid or control in the two seasons. Those results can be attributed to the structural and functional role of calcium in integrity of plant membranes, regulation of ion transport and control activities of cell wall enzymes (Rengel, 1992). In addition Organic acids play important roles in nutrient soluble and restricting the passage of toxic metals across the root and attracting beneficial microorganisms (Jasim *et al*. 2015).

Table 3. Effect of kitasal soil application and foliar applications on plant height, leaf area/plant and fresh and dry weight/plant of pepper during 2015 and 2016 seasons.

Treatments	Plant height (cm)		Leaf area/plant (m^2)		Fresh weight/plant(gm)		Dry weight/plant (gm)	
	S1	S2	S1	S2	S1	S2	S1	S2
Soil								
Kitasal (2ml)	72.50 a	64.20 a	2.685 a	2.864 a	792.23 a	6.35.60 a	150.49 a	146.62 a
Kitasal (1ml)	65.37 b	59.20 b	2.177 b	2.266 b	600.33 b	453.25 b	111.18 b	107.75 b
Without	55.95 c	54.41 c	1.904 c	1.661 c	489.48 c	342.29 c	85.93 c	78.07c
Foliar								
Potassium silicate (200 ppm)	6.33 b	60.00 c	2.329 b	2.275 c	660.33 c	497.80 c	125.04 c	117.83 c
Salicylic acid (250 ppm)	65.11 c	59.55c	2.258 bc	2.246 d	627.33 d	481.43 d	120.22 d	115.05 d
Glutathione (50 ppm)	67.33 ab	61.11 b	2.483 a	2.407 b	691.82 b	537.14 b	127.85 b	125.27 b
glycine-betaine (250 ppm)	68.00 a	61.88 a	2.512 a	2.806 a	734.27 a	579.76a	132.79a	129.78a
Citric acid (2000 ppm)	61.88 e	57.55 f	2.036 d	2.021 f	568.48f	423.64 g	101.95 g	97.60 g
Vegetamin 2ml	63.55 d	58.22 e	2.201 c	2.281e	585.46 e	436.80 f	108.57f	102.05 f
Mix (Half concentration of each foliar treatment)	64.11 cd	58.88 d	2.234c	2.231 d	600.84 e	461.95 e	113.38 e	105.34 e
Control	60.55 f	57.00 g	1.991 d	1.943 g	550.24 g	397.86 h	97.15 h	93.60 h

Table 4. Effect of interaction between kitasal soil application and foliar applications on plant height, leaf area/plant and fresh and dry weight/plant of pepper plants during 2015 and 2016 seasons.

Treatments		Plant height (cm)		Leaf area/plant (m^2)		Fresh weight/plant (gm)		Dry weight/plant (gm)	
		S1	S2	S1	S2	S1	S2	S1	S2
Kitasal 2ml	Potassium silicate (200 ppm)	73.33 abc	65.00c	2.767b	2.786c	834.26 c	665.47 c	163.84 c	157.91 c
	Salicylic acid(250 ppm)	73.00 bc	64.00d	2.586c	2.735d	779.17 d	633.68 d	157.00 d	153.53 d
	Glutathione(50 ppm)	74.00 ab	67.00b	3.171a	3.051b	900.99 b	731.60 b	167.84 b	174.23 b
	glycine-betaine(250 ppm)	75.00a	68.33a	3.208a	3.892a	991.08 a	823.17 a	177.72 a	176.20 a
	Citric acid(2000 ppm)	71.33 cd	62.00 fg	2.319d	2.529e	698.11 fg	5.41.30 g	131.65 g	123.54 g
	Vegetamin 2ml	71.33 cd	62.66 ef	2.551c	2.699d	716.15 ef	563.43 f	137.23 f	130.86 f
	Mix (Half concentration of each foliar treatment)	72.00c	63.00e	2.572 c	2.731d	732.25 e	597.74 e	144.28 e	135.48 e
	Control	70.00 de	61.66 gh	2.305d	2.488e	685.85 gh	528.44 h	124.39 h	121.27 h
Kitasal 1ml	Potassium silicate (200 ppm)	68.00f	59.66j	2.217def	2.279 gh	630.41 j	468.31 k	114.47jk	112.50 k
	Salicylic acid(250 ppm)	65.66g	59.66j	2.189 defg	2.270h	599.56 k	457.95 l	111.78 kl	109.17 l
	Glutathione (50 ppm)	69.00 ef	60.66i	2.245def	2.319g	641.53 ij	485.81 j	117.48 ij	114.95 j
	glycine-betaine (250 ppm)	69.66 def	61.00 hi	2.275de	2.414f	662.94 hi	509.31 i	119.20 i	116.84 i
	Citric acid(2000 ppm)	61.66h	57.66 kl	2.107fghi	2.171i	563.30 l	420.62 n	105.97mn	101.35 n
	Vegetamin 2ml	64.00g	58.33k	2.138efgh	2.256h	572.08 kl	428.14 n	107.73 m	102.52 n
	Mix (Half concentration of each foliar treatment)	64.33g	59.33j	2.160defgh	2.268h	578.33 kl	445.13 m	109.45lm	104.72 m
	Control	60.66 hi	57.33l	2.086fghi	2.156i	554.53 lm	410.72 o	103.93mo	99.93o
without	Potassium silicate (200 ppm)	57.66 jk	55.33n	2.003hij	1.758l	516.32 no	359.62 q	96.82q	83.08r
	Salicylic acid (250 ppm)	56.66 kl	55.00 no	2.000 hij	1.733 lm	503.27 o	352.66 q	91.88 r	82.45r
	Glutathione (50 ppm)	59.00 ij	55.66 mn	2.033ghij	1.852k	532.94 mn	394.01 p	98.23 pq	86.63q
	glycine-betaine (250 ppm)	59.33 ij	56.33 m	2.052ghij	2.111g	548.80 lm	406.80 o	101.45 op	96.31p
	Citric acid (2000 ppm)	52.66 m	53.00q	1.683k	1.363o	444.02 q	309.00 t	680.23 u	67.90u
	Vegetamin 2ml	55.33l	53.66 pq	1.913j	1.589n	468.16 pq	318.83 s	80.74t	72.78t
	Mix (Half concentration of each foliar treatment)	56.00 kl	54.33 op	1.969 ij	1.696 m	491.95 op	343.00 r	86.40s	75.82s
	Control	51.00 m	52.00r	1.583k	1.185p	410.35 r	254.42 u	63.69v	59.60v

Yield and its components:

Effect of soil application:

Data in Table (5) showed that ,soil treatment with kitasal 2ml/l gave the highest significant yield parameters represented in number of fruits/plant ,fruit average weight and total fruit yield also it improved fruit physical characteristics as shown in table (7) hence, it improved fruit length, diameter and flesh thickness at the two seasons . While the lowest one was of the untreated plants in both seasons. These results are in harmony with those of) Saeed and Ahmad 2009 (by using soil application with calcium source witch improved fruit yield of tomato plants.

Effect of foliar application:

Data presented in Table (5) showed the effect of foliar application on yield and its components. It is clear that all treatments significantly affected all studied characters. The application with glycine-betaine was the best in number of fruits/plant, average fruit weight, yield/fed .Followed by glutathione or potassium silicate in the two seasons, respectively .The same trend was appeared in fruit physical characters table 7. Similar results were obtained by Mäkelä *et al*. (1998) on tomato , Sakr *et al*. (2015) and (Kamal, 2013) on pepper respectively.

Effect of interactions:

It is clearly in Table (6) that all interactions significantly improved Yield and its components and physical fruit parameters (Table, 8) in both seasons of study. Generally, the best interaction in number of fruits/ plant, total yield/fed. And fruit average weight was kitasal 2ml/l and foliar application with glycine-betaine, glutathione and potassium silicate respectively.

Table 5. Effect of kitasal soil application and foliar applications on No. of fruits/plant, fruit average weight and total yield/fed. Of pepper during 2015 and 2016 seasons.

Treatments	No. of fruits/plant		Fruit average weight		Total yield Ton/fed.	
	S1	S2	S1	S2	S1	S2
Soil						
Kitasal (2ml)	34.61a	34.41a	66.16a	61.25a	20.79a	22.68 a
Kitasal (1ml)	31.51b	31.26b	60.50b	53.66b	17.09b	18.93b
Without	28.17c	27.45c	55.54c	48.62c	13.90c	15.34c
Foliar						
Potassium silicate (200 ppm)	31.80b	31.37c	61.77b	55.77b	16.92d	19.34b
Salicylic acid (250 ppm)	31.39c	31.11d	61.55b	45.44c	17.68c	19.32b
Glutathione (50 ppm)	32.84a	32.56b	62.66a	56.88a	18.50b	20.47a
glycine-betaine (250 ppm)	33.00a	32.75a	62.94a	57.38a	19.28a	20.80a
Citric acid (2000 ppm)	30.46e	29.81g	59.66d	53.00d	16.26e	17.58d
Vegetamin 2ml	30.76d	30.46f	59.88cd	53.22c	16.27e	18.28c
Mix (Half concentration of each foliar treatment)	30.93d	30.63e	60.38c	53.94c	17.96c	18.89b
Control	30.26e	26.61h	57.00e	51.44e	15.20f	17.20d

Table 6. Effect of interaction between kitasal soil application and foliar applications on No. of fruits/plant, fruit average weight and total yield/fed of pepper plants during 2015 and 2016 seasons.

Treatments		No. of fruits/plant		Fruit average weight		Total yield Ton/fed.	
		S1	S2	S1	S2	S1	S2
Kitasal 2ml	Potassium silicate (200 ppm)	35.04b	34.83b	67.66ab	63.66b	22.05b	23.51bc
	Salicylic acid (250 ppm)	34.88b	34.66b	67.00b	60.33c	21.27c	23.10cd
	Glutathione (50 ppm)	36.26a	36.05a	68.33a	65.00a	22.92a	24.04ab
	glycine-betaine (250 ppm)	36.39a	36.19a	68.50a	65.83a	23.17a	24.49a
	Citric acid (2000 ppm)	33.36d	33.12d	64.66c	58.66d	19.71d	21.10fg
	Vegetamin 2ml	33.90c	33.74c	64.66c	58.66d	19.73d	21.82ef
	Mix (Half concentration of each foliar treatment)	33.93c	33.77c	64.83c	59.50cd	19.89d	22.40de
	Control	33.13d	32.88d	63.66cd	58.33d	19.33d	20.95fg
Kitasal 1ml	Potassium silicate (200 ppm)	31.87ef	31.65fg	61.00e	54.33f	17.56f	19.20h
	Salicylic acid (250 ppm)	31.67fg	31.43g	61.00e	53.66fg	17.00g	19.07h
	Glutathione (50 ppm)	32.05ef	31.81ef	63.00d	56.33e	18.25e	20.40g
	glycine-betaine (250 ppm)	32.27e	32.04e	63.66cd	57.00e	18.39e	20.46g
	Citric acid (2000 ppm)	30.90h	30.69ij	58.66g	52.00h	16.28h	17.80jk
	Vegetamin 2ml	31.19h	30.88hi	59.33fg	52.66gh	16.47gh	18.12ij
	Mix (Half concentration of each foliar treatment)	31.30gh	31.02h	60.00ef	53.33fg	16.77gh	18.92hi
	Control	30.87h	30..52j	57.33h	50.00i	15.59i	17.52jk
without	Potassium silicate (200 ppm)	28.49g	27.63l	56.66hi	49.33ij	14.04k	15.65l
	Salicylic acid (250 ppm)	27.63k	27.25m	65.66hi	49.33ij	13.63kl	15.44l
	Glutathione (50 ppm)	30.21i	29.81k	56.66hi	49.33ij	14.90j	16.89k
	glycine-betaine (250 ppm)	30.34i	30.04k	56.66hi	49.33ij	14.93j	17.49jk
	Citric acid (2000 ppm)	27.13lm	25.61o	55.66i	48.33j	13.10l	14.26m
	Vegetamin 2ml	27.20klm	26.77n	55.66i	48.33j	13.32l	14.90lm
	Mix (Half concentration of each foliar treatment)	27.55kl	27.11m	56.33hi	49.00ij	13.58kl	15.36l
	Control	26.78m	25.43o	50.00i	46.00k	12.32m	12.71n

Whereas the lowest was 0 and 1 ml/l kitasal with citric acid and non-treated plants in both seasons. These results showing the additive effect of soil and foliar treatments in improving yield by enhancing nutrients uptake, alleviating salinity and scavenging harmful toxic compounds (Pompella *et al*. 2003; Demiral and Turkan, 2006).

Table 7. Effect of kitasal soil application and foliar applications on fruit length, fruit diameter and flesh thikness of pepper plants during 2015 and 2016 seasons.

Treatments	Fruit length mm		Fruit diameter mm		Flesh thickness mm	
	S1	S2	S1	S2	S1	S2
Soil						
Kitasal (2ml)	92.41 a	92.16a	54.25a	54.11a	4.46a	4.50a
Kitasal (1ml)	87.83b	87.68b	49.12b	49.09b	3.99b	4.04b
Without	77.66c	78.16c	45.16c	45.53c	3.69c	3.77c
Foliar						
Potassium silicate (200 ppm)	87.55b	87.70b	51.00bc	51.25b	4.12b	4.12c
Salicylic acid (250 ppm)	86.33c	86.27c	50.55c	49.77c	4.04c	4.06d
Glutathione (50 ppm)	88.88a	88.96a	51.44ab	51.57ab	4.17b	4.18b
glycine-betaine (250 ppm)	89.77a	89.50a	52.00a	51.87a	4.30a	4.37a
Citric acid (2000 ppm)	83.44e	83.51e	47.22ef	47.66e	3.94d	3.98e
Vegetamin 2ml	84.88d	85.40d	47.88e	48.53d	3.96d	4.06d
Mix (Half concentration of each foliar treatment)	86.00cd	85.79cd	49.22d	49.35c	4.00cd	4.06d
Control	80.88f	80.87f	46.77f	46.61f	3.85e	3.96e

Table 8. Effect of interaction between kitasal soil application and foliar applications on fruit length, fruit diameter and flesh thickness of pepper plants during 2015 and 2016 seasons.

Treatments		Fruit length mm		Fruit diameter mm		Flesh thickness mm	
		S1	S2	S1	S2	S1	S2
Kitasal 2ml	Potassium silicate(200 ppm)	94.00b	94.33b	57.00ab	57.22a	4.50bc	4.46c
	Salicylic acid (250 ppm)	91.66c	91.33c	56.00b	53.39b	4.46bc	4.46c
	Glutathione (50 ppm)	95.00b	95.16ab	57.33ab	57.44a	4.53b	4.53b
	glycine-betaine (250 ppm)	97.33a	96.11a	58.00a	57.77a	4.86a	4.93a
	Citric acid (2000 ppm)	90.00 cd	89.83de	50.66de	51.16d	4.33c	4.36d
	Vegetamin 2ml	90.33cd	90.00cde	51.00d	52.50c	4.33d	4.46c
	Mix (Half concentration of each foliar treatment)	91.33c	90.72cd	53.33c	52.83bc	4.40cd	4.46c
	Control	89.66cde	89.83de	50.66de	50.61de	4.3d	4.33d
Kitasal 1ml	Potassium silicate(200 ppm)	88.66de	88.94ef	49.33ef	49.61fgh	4.60ef	4.06f
	Salicylic acid(250 ppm)	88.33de	88.61efg	49.33ef	49.44gh	3.96fg	3.96g
	Glutathione(50 ppm)	89.66cde	89.11ef	50.00de	50.16efg	4.16.e	4.16e
	glycine-betaine(250 ppm)	89.66cde	89.39def	50.66de	50.44def	4.16e	4.33d
	Citric acid(2000 ppm)	86.00fg	86.22h	48.00fgh	48.00jk	3.90gh	3.96g
	Vegetamin 2ml	87.33ef	87.50gh	48.33fg	48.55ij	3.90gh	3.96g
	Mix (Half concentration of each foliar treatment)	88.00def	87.94fg	49.33ef	49.00hi	3.90gh	3.96g
	Control	85.00g	83.77i	48.00fgh	47.50kl	3.90gh	3.86h
without	Potassium silicate (200 ppm)	80.00ij	79.83j	46.66hi	46.94lmn	3.80hi	3.83h
	Salicylic acid (250 ppm)	79.00jk	78.89j	46.33i	46.50mn	3.70ij	3.76i
	Glutathione (50 ppm)	82.00hi	82.61i	47.00ghi	47.11lm	3.83gh	3.86h
	glycine-betaine (250 ppm)	82.33h	83.00i	47.33ghi	47.39kl	3.86gh	3.86h
	Citric acid (2000 ppm)	74.33l	74.50k	43.00k	43.83o	3.60j	3.66j
	Vegetamin 2ml	77.00k	78.72j	44.33j	44.55o	3.66j	3.76i
	Mix (Half concentration of each foliar treatment)	78.66jk	78.72j	45.00j	46.22n	3.70ij	3.76i
	Control	68.00m	69.00l	41.66l	41.72p	3.36k	3.63 j

CONCLUSION

It could be concluded that soil application with kitasal at 2ml/l and spraying with glycine-betaine on sweet pepper plants under salinity conditions gave the highest values of vegetative growth represented by plant height, leaf area fresh and dry weights and fruit yield and its components represented by fruit weight, yield/plant, and total yield/fed.

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استخدام بعض المركبات لتخفيف اجهاد الملوحة على نباتات الفلفل الحلو

سمير طه محمود العفيفى[١] ، محمود محمد زغلول[١] ، السعيد لطفى السيد فتحى [٢] و محمد سليمان وهبه[٢]
[١] قسم الخضر والزينة-كلية الزراعة - جامعة المنصورة.
[٢] قسم الخضر- معهد بحوث البساتين- مركز البحوث الزراعية- الجيزة- مصر

أجريت تجربتين بمزرعة خاصة بمنطقة الدعاء، بلطيم، محافظة كفر الشيخ-مصر خلال الموسمين ٢٠١٥-٢٠١٦ لدراسة تأثير بعض المنظمات الأسموزية ومضادات الأكسدة لتخفيف الاثر الضار لاجهاد الملوحة على النمو الخضرى والمحصول لنباتات الفلفل الحلو هجين توب ستار وذلك تحت ظروف الارض الرملية والري بالتنقيط خلال العروة الصيفية المبكرة. ويمكن تلخيص النتائج كالتالى: المعاملة الأرضية بمركب كيتاسال بتركيز ٢مل/لتر أعطت أعلى النتائج فى كلا من: القياسات الخضرية متمثلة فى طول النبات، الوزن الغض والمادة الجافة، مساحة السطح الورقى وكذلك محصول الثمار/فدان مقارنة بباقى المعاملات فى كلا الموسمين. كل معاملات الرش أظهرت زيادة معنوية على كل القياسات محل الدراسة مقارنة بالنباتات الغير معاملة. وكانت المعاملة الأكثر تفوقا جليسين بيتايين بتركيز ٢٥٠ جزء فى المليون متبوعة بالجلوتاثيون بتركيز ٥٠ جزء فى المليون أو سيليكات البوتاسيوم بتركيز ٢٥٠ جزء فى المليون بالترتيب فى كلا الموسمين. التفاعل بين المعاملة الأرضية بالكيتاسال بتركيز ٢مل/لتر مع المعاملة بالرش بالجليسين بيتايين بتركيز ٢٥٠ جزء فى المليون أعطت أعلى النتائج فى القياسات الخضرية (طول النبات، مساحة السطح الورقى، الوزن الغض ووزن المادة الجافة) وكذلك القياسات المحصولية (متوسط وزن الثمرة، محصول النبات ومحصول الفدان). مما سبق يمكن القول بأنه باستخدام مركب كيتاسال بتركيز ٢مل/لتر كمعاملة أرضية مع المعاملة بالرش بالجليسين بيتايين بتركيز ٢٥٠ جزء فى المليون يمكن تحسين النمو والمحصول لنباتات الفلفل الحلو النامية تحت ظروف الملوحة.