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EFFECT PF MOLASSES ON SALINITY TOLERANCE OF TOMATO PLANTS

BY

Abo El-Hamd, A.S.A.
Department of Horticulture, Faculty of Agriculture, Al-Azhar University

ABSTRACT

Two pot experiments were conducted during the two successive summer seasons of 2002 and 2003 to study the effect of molasses on growth, chemical composite, yield and its components and fruit quality of tomato. Plants irrigated with saline water at the concentration of 33.3 and 50 g/pot. Molasses was added at the concentrations of 33.3 and 50 g./Pot. Molasses treatments increased plant height, fresh and dry weight in comparison with the control treatment. Also, all molasses treatments give rise increases in leaf chlorophyll content, nitrogen, phosphorus percentage in comparison with the control treatment. Significant increases were noticed in fruit T.S.S., ascorbic acid, dry matter and total sugars content, similarly, molasses treatments increased significantly marketable yield and total yield in comparison with the control treatment. The best results were exerted from the application of molasses treatment at the concentration of 33.3 g/pot (250 kg.\Feddan).

Molasses treatments increased number of clusters\plant fruit set, fruit weight in the two seasons. Molasses treatments decreased the unmarketable yield, fruit firmness and acidity in the two seasons.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill), is one of the major and most important vegetable crops in Egypt. There is a high demand on tomatoes for local market and export. It is standing well over the year in most Egyptian governorates.

Increasing salinity in some new cultivated areas could face tomato production either in the new reclaimed soils or in the old valley soils. Salt induced growth suppression is a major obstacle facing crop production on saline lands. Irrigation with high saline water decreased tomato plant growth i.e. plant height, fresh and dry weight and total chlorophyll content, Ahmed, (1998), and Cuartero *et al.* (2003).

Number of flowers and fruit setting (%) for tomato plant decreased under saline stress, Ahmed, (1998) and Eata, (2001).

Chemical composition of tomato plant foliage represented as mineral composition i.e. (N, P, K) decreased under saline stress, Hassan, (1999). Also, under saline stress, fruit weight, marketable and total yield for tomato plants decreased, Amico *et al.* (2003), but unmarketable yield increased, Eata, (2001), and Magan *et al.* (2004).

Increased saline water for tomato plants leading to increased fruit quality i.e. fruit firmness, total soluble solids, vitamin C, acidity (%), total sugars and dry matter percentage, Stamatakis *et al.* (2003), Abdel-Gawad *et al.* (2003), and Magan *et al.* (2004).

Therefore, the present investigation was undertaken to evaluate the role of molasses on growth, chemical composition, yield and fruit quality of tomato plants grown saline water stress.

Molasses, originating from the beet sugar process, Molasses contains glycinebetaine which environmentally safe, non-toxic and water soluble. Plant growth, the rat of net photosynthesis and fruit yield of tomato plants grown in saline soils increased when glycinebetaine was applied (Makela *et al.*, (1998) and Makela *et al.* (1999).

MATERIAL AND METHODS

Pots experiment were conducted in this work during the two successive summer seasons of 2002 and 2003 at Kaha Experimental Farm, Horticultural Research Institute, Agriculture Research Center (Qalyoubia Governorate) to study the effect of molasses on salinity tolerance in Master 100 tomato hybrid (salinity sensitive, introduced from Horticultural Research Institute, Agriculture Research Center).

The physical and chemical analysis of the soil used in this investigation is shown in Table (1).

Table (1): The physical and chemical analysis of the pots soil in 2002 and 2003 seasons.

Soil properties	2002 season	2003 season
I. Physical analysis		
Sand (%)	92.72	92.80
Silt (%)	4.0	3.8
Clay (%)	3.28	3.4
II. Chemical analysis		
pH	8.3	8.4
EC (Mm / cm)	0.21	0.23
N (ppm)	8	10
p (ppm)	11	13
K (ppm)	68	64
Fe (ppm)	0.4	0.6
Cu (ppm)	0.02	0.04
Zn (ppm)	0.1	0.3
Mn (ppm)	0.6	0.8

This experiment included 3 treatments, which were as follows:

1. Beet molasses at rates of 33.3 gm / pot (250 kg / fed.).
2. Beet molasses at rates of 50 gm / pot (300 kg / fed.).
3. Control (without molasses [only saline water]).

All plants in this experiment irrigated by saline water (4000 ppm) from Karoun Lake after dilution by tap water (260 ppm), the concentration of Karoun Lake salty water was 37300 and 36900 ppm salts in 2002 and 2003 seasons, respectively. The chemical analysis of the saline drainage water (meq / l) in this investigation is shown in Table (2).

Table (2): The chemical analysis of the saline water (meq/ l).

Concen-tration	EC (ds/m)	CO_3^-	HCO_3^-	CR	SO_4^{--}	CA^{++}	Mg^{++}	Na^+	K^+
260 ppm	0.41	-	3.3	1.4	0.1	1.9	1.3	1.4	0.2
4000 ppm	6.25	-	3.3	45.9	0.8	4.1	13.6	31.5	0.8

The analysis of beet molasses shown in Table (3). Plants were adding with an aqueous solution of molasses three times during the growing season after 3, 6 and 9 weeks from transplanting (Ahmed, 1998).

Table (3): The analysis of beet molasses.

Beet molasses composition	%)
Water	17
Sucrose	66
Fructose	1
Glucose	1
Glycinebetaine	6
Amino acids	8
Sterols	0.3
Phospholipids	0.5
Wax	0.2

Seeds of tomato hybrid (Master 100) were sown in 6th February in foam pots under the condition of greenhouse in both two seasons of study. The transplants of tomato hybrid were transplanted in March 27th in both two seasons of study; two uniform seedlings were transplanted in each pot, placed in the open field. Thinning took place leaving one plants in a pot.

The experiment included 108 pots resulting from combination of 3 treatments within 4 replicates and every replicate consisted of 9 pots (30 cm in diameter and 50 cm depth) was filled with 13 kg washed sand. Pots periodically every 2-3 days, with 1000 ml to keep the water content at field capacity. Plastic pots were perforated to allow drainage.

Every pot was received 5.2 gm (400 kg / fed.), 309 gm (300 kg / fed.) and 2 gm (150 kg/fed.) of ammonium sulphate (20.6 % N), Calcium superphosphate (15.5 % P_2O_5) and Potassium sulphate (48 % K_2O), respectively, Hanan *et al.* (1978). Pots were arranged in Complete Randomized Block Design with three replicates.

Average temperature and relative humidity of the experimental region are presented in Table (4).

Table (4): Average temperature and relative humidity of the experimental region in 2002 and 2003 seasons.

Month	2002		2003	
	Mean °C	R.H. %	Mean °C	R.H. %
January	14.91	64.11	18.00	40.81
February	14.94	61.54	16.21	40.59
March	17.92	68.32	16.21	61.60
April	20.42	60.77	20.76	60.37
May	24.99	57.21	25.43	55.66
June	28.81	56.33	26.95	57.63
July	29.31	60.02	27.70	65.45
August	30.20	64.52	28.05	67.50
September	30.34	51.33	27.32	64.67
October	22.81	45.31	25.45	66.03
November	21.97	41.15	21.45	62.28
December	18.69	40.06	16.14	65.68

Data were recorded on plant growth, chemical composition, flowering characteristics, yield and fruit quality.

Determination procedures:

A. Plant growth:-

A random sample of two plants were taken from each plot at 50 and 70 days after transplanting in 2002 and 2003 seasons for measuring the following data:-

1. Plant height (cm) was measured from cotyledons level to plant top.
2. Fresh weight of aerial part (stem and leaves) was determined in gm / plant.

B. Chemical composition:-

1. Dry weight of aerial part (stems and leaves) (gm) / plant at 50 and 70 days after transplanting, plants were oven dried at 70° C till a constant weight.
2. Total chlorophyll content at 70 days after transplanting, was measured in the leaves using MINOLTA - SPAD 501 chlorophyll meter (MINOLTA CO., LTD. Japan), (Yadava, 1986).
3. Macro and micro elements, at 70 days after transplanting during 2002 and 2003 seasons, sample of fresh leaves (the 4th leaf from the plant top) were taken and considered the most representative ones for plant analysis. The

leaves were oven dried at 70° C till a constant weight. The dry matter was finely ground and wet digested with H_2O_2 and concentrated H_2SO_4 for the determination of nitrogen, phosphorus and potassium according to the following methods:

- Nitrogen was determined in the digestion product, using the Micro – Kjeldahl method (Piper, 1947).
- Phosphorus was determined calorimetrically in the above mentioned digestion product, Spectrophotometrically (King, 1951).
- Potassium was determined in the above mentioned digestion product, using the Flame photometer (Jackson, 1967).

C. Flowering characteristics:-

1. Number of clusters / plant, was counted in flowering stage.
2. Fruit setting percentage (%), according to the formula:
   = No. of fruit set / Total flowers X 100

D. Yield and its components:-

Yield and its components, at harvesting time collected data concerning the yield and its components such as:-

1. Average fruit weight (gm):- ten fruits from each treatment were taken randomly from the third picking as a representative sample for determine average fruit weight (gm).
2. Unmarketable yield (gm / plant), this includes weight of rotten fruits.
3. Marketable yield (gm / plant), was determined after excluding rotten fruits.
4. Total yield (gm / plant), was determined as total weight of fruits during the harvesting period.

E. Fruit quality:-

1. Fruit Firmness (gm / cm2):- ten fruits from each treatment were taken randomly from the third picking as a representative sample for determine Firmness fruit (gm / cm2) by a needle type pocket penetrometer.
2. Total soluble solids (T.S.S. %), was determined by using hand referactometer according to A.O.A.C. (1970).
3. Titratable acidity (Citric acid %), was determined according to A.O.A.C. (1970).
4. Vitamin C (Ascorbic acid mg/100 gm F.W.), was determined in fresh weight by using the 2, 6 Dichlorophenolindolphenol method described in A.O.A.C. (1970).
5. Fruit dry matter percentage (%):- according to the formula:
   = Dry weight / Fresh weight X 100
6. Total sugars, ware determined in fruits as mg/100 gm dry weight, according to smith *et al.* (1956).

Statistical analysis:-

All data collected were subjected to the Statistical analysis according to Snedecor and Cochran (1968). The data of treatments were compared, using least significant difference (LSD at 5 %) method as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Plant growth:-

Data presented in Table (5) show clearly that, all used treatments seemed to have a stimulating effect on the growth characters of tomato plant under study as compared with the control treatment (without treatments [only saline water]) at 50 and 70 days after transplanting in both two seasons.

Table (5): Effect of molasses on growth characteristics of tomato plants at 50 and 70 days after transplanting during seasons of 2002 and 2003.

Treatments	2002 Season					
	Plant height (cm)		F.W/plant (gm)		D.W./plant (gm)	
	50 days	70 days	50 days	70 days	50 days	70 days
Control	29.1	34.3	43.0	59.0	18.7	24.1
Molasses 33.3 gm/pot	39.4	52.3	88.0	112.7	30.3	34.7
Molasses 50.0 gm/pot	37.6	51.2	80.8	97.6	27.4	33.1
L.S.D. at (5%)	0.82	1.67	3.89	6.36	1.33	1.48
	2003 Season					
Control	30.2	30.7	45.5	54.6	21.7	24.7
Molasses 33.3 gm/pot	40.5	51.6	91.5	113.5	35.2	33.7
Molasses 50.0 gm/pot	38.6	50.1	79.0	92.1	30.1	31.1
L.S.D. at (5%)	0.66	0.95	3.31	2.36	1.22	1.12

The maximum values of growth characters of tomato plants, expressed as plant height, fresh and dry weight were more distinct via using molasses 33.3 gm treatment, which came in the first rank, followed by the treatments of molasses 50 gm at 50 and 70 days after transplanting in both two seasons.
The obtained results are in agreement with those reported by Makela *et al.* (1999) and Eata, (2001).

A common role of molasses, which contains glycinebetaine, is as a compatible solute in osmotic adjustment of the cytoplasmic compartments where it may accumulate while ions are sequestered in the vacuole (Matoh *et al.*, 1987). In this concern, the photosynthetic activity was increased when tomato plants were sprayed by glycinebetaine. Similar results have been reported by Makela *et al.* 1999). Also, the promoting effect of molasses which contain glyainbetaine on plant growth under salinity stress is due to glyainbetaine was found to protect protein and membrane functions from stress conditions such as drought and salt stresses, by playing an anti transpiration agent (Hanson *et al.*, 1995).

The adverse effect of salt stress on plant growth, which came in control treatment, is attributed to one of more of follows:

- The inhibition in cell division and cell elongation\ that reflect on reduction in cell size and number of cells per unit area.
- The imbalance in hormones content in plants, as salinity increased it caused a decreased transport of kinetin from root to leaves (Bernstein, 1975).

B. Chemical composition:-

Data presented in Table (6) clearly that, the high values of chlorophyll content, N, P, and K in tomato leaves were obtained with molasses 33.3 gm treatment whereas, the plants which treated by molasses 50 gm which came in the second rank at 70 days from transplanting in both two seasons. The lowest value of chlorophyll content, N, P, and K in tomato leaves were obtained with the control (only saline water) in both two seasons. The obtained results are in agreement with those reported by Makela *et al.* (1999).

Table (6): Effect of molasses on chemical composition of tomato leaves at 70 days after transplanting during seasons of 2002 and 2003.

Treatments	2002 Season			
	Chlorophyll content	N (%)	P (%)	K (%)
Control	38.1	2.9	0.38	2.0
Molasses 33.3 gm/pot	53.0	3.4	0.46	2.7
Molasses 50.0 gm/pot	48.2	3.0	0.41	2.3
L.S.D. at (5%)	1.6	0.07	0.007	0.06
	2003 Season			
Control	38.3	2.6	0.37	2.1
Molasses 33.3 gm/pot	53.1	3.5	0.48	2.8
Molasses 50.0 gm/pot	48.6	3.1	0.40	2.4
L.S.D. at (5%)	2.91	0.05	0.005	0.06

A common role of molasses which contains glycinebetaine is as a compatible solute in osmotic adjustment of the cytoplasmic compartments where it may accumulate while ions are sequestered in the vacuole (Mato.) *et al.*, 1987). In this concern, the photosynthetic activity was increased when tomato plants were sprayed by glycinebetaine. The promoting effect of molasses which contain glyainbetaine on plant growth under salinity stress is due to glyainbetaine was found to protect protein and membrane functions from stress conditions such as drought and salt stresses, by playing an anti transpiration agent (Hanson *et al.*, 1995).

With regard to the obtained results a bout the effect of control treatment (only saline water) on chlorophyll content might be attributed to that the role of salinity in this respect it caused an adverse effect on water relationship of plant and consequently decrease photosynthesis process and reduction in carbon fixation in photosynthesis (Bernstein, 1975). The higher reduction in N, P and K concentration in tomato leaves under salinity suggest that high sodium uptake induced the low K uptake that has been implicated in growth and yield reduction of tomato crop (Crvajal *et al.*, 1999).

C. Flowering characteristics:-

Data resented in Table (7) showed that all used treatments caused a significant increase in No. of clusters and fruit setting compared with the control treatment whereas, using molasses 33.3 gm treatment being the most effective as compared with the other treatments for increasing the No. of clusters and fruit set percentage while, using the treatments of molasses 50 gm which came in the second rank, these results cleared in both two seasons. The obtained results are in agreement with those reported by Makela *et al.* (1999).

Table (7): Effect of molasses on flowering yield quality of tomato plants seasons of 2002 and 2003.

Treatments	No. of Clusters/ plant	Fruit setting (%)	Average fruit weight (gm)	Unmarketable *Y/P (gm)	Marketable *Y/P (gm)	Total *Y/P (gm)
	2002 Season					
Control	8.3	46.0	48.0	93.3	359.6	453.8
Molasses 33.3 gm/pot	10.1	77.6	52.7	70.6	451.6	522.2
Molasses 50.0 gm/pot	9.4	69.6	51.3	73.1	427.1	500.1
L.S.D. at (5%)	0.56	6.85	0.79	1.94	6.53	7.63
	2003 Season					
Control	7.1	43.4	50.2	95.7	363.8	459.5
Molasses 33.3 gm/pot	9.0	72.2	56.0	70.0	456.4	526.4
Molasses 50.0 gm/pot	8.6	58.9	52.7	71.2	433.4	504.7
L.S.D. at (5%)	0.57	3.60	0.62	2.50	31.45	7.95

* **Y/P** = yield/plant

With regard to the obtained results a bout the effect of control treatment (only saline water) on No. of clusters and fruit setting might be attributed to either the adverse role of salinity on in balance in nutritional cations in tissues of the salts affected plant and the retardant effects on plant grown that may be reflect on the reduction in flowering parameters. Similar results have been reported by Ahmed, (1998).

D. Yield and its components:-

Data presented in Table (7) clearly that, all used treatments caused increasing average fruit weight, marketable yield/plant and total yield/plant for tomato plants compared with the control treatment (without treatments [only saline water]).

The maximum values of yield and its components of tomato plant, expressed as average fruit weight, marketable yield/plant and total yield/plant were more distinct via using molasses 33.3 gm treatment which came in the first rank, followed by the treatments molasses 50 gm and control, respectively. On the other hand, all treatments decreased unmarketable yield compared with the control (without treatments [only saline water]), these results cleared in both two seasons. The results are in agreement with which obtained by (.Makela *et al.*, (1998.) and Makela *et al.* (1999).

Average fruit weight, marketable yield/plant and total yield/plant increased by used molasses 33.3 gm and molasses 50 treatments may be attributed to the positive effects of these treatments on plant growth, Table (5), chlorophyll content, Table (6) as well as mineral content of leave Table (6) which may be consequently increase yield and its components.

With regard to the reduced in average fruit weight, marketable yield/plant and total yield/plant by used control treatment may be attributed to the adverse effects of salinity on plant growth, Table (5) and chlorophyll content, Table (6) as well as mineral content of leaves, Table (6). Which may be consequently reduce yield and its components.

Increasing unmarketable yield by control treatment (only saline water) may be attributed to increasing Blossom - end rot in tomato fruits which came by reason Ca^{+2} deficiency in tomato fruits by increased saline water (Eata, 2001).

E. Fruit quality:-

Data presented in Table (8) show the effect of molasses 33.3 gm and molasses 50 gm treatments on fruit quality, expressed as fruit firmness, T.S.S., Acidity, ascorbic acid, dry matter (%) and total sugars. Significant increase in most fruits quality was obtained due to the application of either molasses 33.3 gm and molasses 50 gm treatments compared with the control, but fruit firmness and acidity not affected by molasses 33.3 gm and molasses 50 gm treatments, in both two season. These results are in agreement with those reported by Makela *et al.*, (1998) and Makela *et al.* (1999).

Table (8): Effect of molasses on fruit quality of tomato plants during seasons of 2002 and 2003.

Treatments	Fruit firmness (gm/cm2)	T.S.S. (%)	Acidity (%)	Ascorbic acid (mg/100gm F.W.)	% Fruit Dry Matter	Total Sugars (mg/100gm D.W.)
	2002 Season					
Control	435	7.1	0.56	30.1	7.6	3680
Molasses 33.3 gm/pot	399	7.8	0.45	33.4	8.6	3721
Molasses 50.0 gm/pot	402	7.6	0.46	31.1	8.1	3701
L.S.D. at (5%)	0.35	0.08	0.007	0.50	0.27	38
	2003 Season					
Control	429	7.2	0.59	30.2	7.8	3660
Molasses 33.3 gm/pot	390	7.6	0.46	33.6	8.7	3731
Molasses 50.0 gm/pot	407	7.5	0.47	31.6	8.2	3711
L.S.D. at (5%)	6.73	0.07	0.03	041	023	30

With regard to the obtained results about the effect of control treatment (only saline water) on acidity and fruit firmness, tomato fruits grown under salt stress show higher organic acid contents and higher titratable acidity than fruits grown with fresh water (Mitchell *et al.*, 1991). The accumulation of organic acids in tomato fruit seems to counterbalance the cation (K^+ and Na^+) excess respective to anions (Cl^- and $SO_4^{(-2)}$) so maintaining fruit pH (Davies, 1964): the difference

between cations and anions is wider in salt-treated fruit and hence the higher concentration of organic acids seen in fruits from Stalinized plants.

With regard to increased fruit firmness under salinity stress is due to increased salinity effects originating from reduced fruit water content due to adaptation of the plant to salinity (Petersen *et al.* 1998).

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تأثير المولاس على تحمل نباتات الطماطم للملوحة

عبد النعيم سعيد عبد الرحيم أبو الحمد
قسم البساتين – كلية زراعة – جامعة الأزهر

أجريت هذه الدراسة على محصول الطماطم صنف ماستر ١٠٠ خلال موسمي ٢٠٠٢ ٢٠٠٣ بمزرعة بحوث البساتين- قها- قليوبية وذلك لدراسة تأثير المولاس تركيزات ٣٣,٣سم، ٥٠ جم ، لكل أصيص (٢٥٠، ٣٥٠ كجم/فدان) على النمو، المحتوى الكيماوي، المحصول ومكوناته، جودة الثمار لنباتات الطماطم تحت الري بمياه مالحة ٤٠٠٠ جزء في المليون (مخففه من مياه بحيرة قارون). ويمكن تلخيص أهم النتائج المتحصل عليها في الآتي:-

- أدى استخدام المولاس بتركيزاته المختلفة إلى زيادة طول النبات، والوزن الطازج والجاف لنباتات الطماطم مقارنه بالكنترول (مياه مالحة فقط).
- كما أدى استخدام المعاملات السابقة إلى زيادة محتوى الأوراق من الكلوروفيل،

النسبة المئوية لكل من النيتروجين والفوسفور والبوتاسيوم مقارنة بالكنترول.

- كما لوحظ زيادة معنوية في نسبة المواد الصلبة الذائبة الكلية، فيتامين ج، نسبة المادة الجافة للثمار والسكريات الكلية نتيجة استخدام تلك المعاملات.
- أدى استخدام المولاس بجميع تركيزاته إلى زيادة عدد العناقيد الزهرية وكذلك زيادة نسبة العقد للثمار ووزن الثمار.
- كانت هناك زيادة معنوية في المحصول القابل للتسويق والمحصول الكلي نتيجة استخدام تلك المعاملات مقارنه بالكنترول، كانت أفضل النتائج المتحصل عليها هي استخدام المولاس بتركيز ٣٣,٣جم/أصيص (٢٥٠كجم/فدان).
- كما أدى استخدام المولاس بجميع تركيزاته إلى نقص المحصول غير القابل للتسويق وكذلك صلابة وحموضة الثمار.