Effect of Spraying with some Nutrient Elements on Tolerance Beachilyfolia Pear Rootstock to Salinity

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Abstract: The present investigation was carried out during 2008 and 2009 seasons in the experimental farm belonging to El-Kanater Horticultural Research Station, Kalyubeia Governorate Egypt to study effect of some nutrient elements on tolerance beachilyfolia pear rootstock to salinity. The following measurements were recorded: vegetative growth, nutritional status and some physiological properties of Beachilyfolia pear rootstock, irrigated with saline solution at 6000 ppm with 6 SAR and high chloride level (Cl : So4). Zinc at 50 ppm, Potassium at 250 ppm and Phosphorus at 250 ppm were used in this study to give more explanation about the protect against salt injury. The results revealed that, foliar spray treatments caused a significant increase of some growth measurements (stem height, root length, number of branches & leaves, leaf area, stem diameter and fresh & dry weights of plant organs), leaf photosynthetic pigments content (chlorophyll A, B and carotenoids), leaf mineral content (N, P, K, Na, Fe Mn and Zn), physiological properties (leaf succulence grade, leaf water potential and leaf relative turgidity) of beachilyfolia pear rootstock transplants during 2008 and 2009 consecutive seasons. On the contrary, leaf sodium and proline contents and leaf osmotic pressure took the other way around during the study.

[Faten, H. M. Ismaeil and Wahdan, M. T. **Effect of Spraying with some Nutrient Elements on Tolerance Beachilyfolia Pear Rootstock to Salinity**. Journal of American Science 2010;6(12):1647-1654]. (ISSN: 1545-1003). http://www.americanscience.org.

Key wards: Beachilyfolia, pear, rootstock, nutrient elements, salinity.

1. Introduction:

Pear is one of the most important deciduous fruits in Egypt. For that, in recent years there has been a steady increase in the area cultivated with pear to meet the continuous rise in demand for pear fruits for local consumption in Egyptian markets.

Undoubtedly, the expansion of agricultural land needs a great amounts of suitable irrigation water which already is not sufficient to meet all the expected demands in this respect. In addition to that, the limited amounts of water is an ever growing crisis that may face us in Egypt in future due to the natural aridity in the region, the increasing population and land reclamation projects which represented a very important sector in the agricultural development programs for increasing the cultivated area. Salinity is one of the most serious and oldest environmental problems affecting approximately one third of earth's irrigation land. There are many factors affecting the salinity-yield relationship such as the physical and chemical conditions of the soil, climate and farming practices (Schreiner and Ludders, 1992).

The possibility of using saline water for irrigation, especially underground water is considered as a limiting factor and great value for the success of the projects of new land reclamation, which it is still very limited source until now, however many problems are expected to arise. These problems would be related to the excessive accumulation of saline salts in the soil because this water contains a considerable amount of harmful salts as an actual limiting factor for growth and productivity of transplants and fruit trees (Sharaf *et al.,* 2006).

There is a little of available information for fruit growers about the possibility of some pear and other deciduous rootstocks to grow under conditions of new reclaimed lands and probability of these rootstocks to tolerance for irrigation with saline water (Kabeel, 1985, Bondok *et al*., 1995, Osman, 2005 and khamis *et al.,* 2008) on some deciduous rootstocks transplants.

The present study carried out to investigate the effect of spraying with some nutrient elements (K, P and Zn) on tolerance beachilyfolia pear rootstock to salinity.

2. Materials and methods

The present investigation was carried out throughout the two consecutive seasons of 2008 and 2009 in the experimental farm belonging to El-Kanater Horticultural Research Station, Kalyubeia Governorate, Egypt.

Uniform and healthy one-year-old transplants of *Pyrus beachilyfolia* rootstock was the plant materials used in this study. In both seasons of study and during the first week of February, pear rootstock transplants were transplanted individually each in clay pot of 35 cm. in diameter that previously had been field with specific weight of media consisting of clay and sand at equal proportion (by volume). Mechanical and chemical analysis of the experimental soil from 0 to 30 cm. depth just before pear investigated treatments had been started are shown in Table (1). These standard methods used in this respect described by A.O.A.C, (1990).

Table (1): Physical and chemical analyses of the experimental soil.

Depth (cm.)	Sand %	Silt %	Clay %	Soil texture	Soil extract pH 1:25	E.C. (1:5) ds/m	Soluble cations				Soluble anions			
							Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
0-30	21.10	25.90	52.60	Clay loam	7.86	0.195	0.74	0.22	0.68	0.17	0.55	0.80	-	0.47

Irrigation with the saline solution was carried out twice weekly by adding (¾) liter per each pot starting from the first week of March until the last week of September throughout the two seasons of study. To prevent salts accumulation pots irrigated with tap water every 12 days, then rewatering with salt solutions applied the next day. Control treatment was supplied periodically two times every week with tap water only at (¾) liter/pot. The following treatments are used:

1- Tap water irrigation (control).
2- Irrigation with 6000 ppm saline solution of SAR6 and high Cl: SO_4 level plus tap water spray.
3- Irrigation with 6000 ppm saline solution of SAR6 and high Cl: SO_4 level + Zn at 50 ppm spray.
4- Irrigation with 6000 ppm saline solution of SAR6 and high Cl: SO_4 level + K at 250 ppm spray.
5- Irrigation with 6000 ppm saline solution of SAR6 and high Cl: SO_4 level + P at 250 ppm spray.

The different treatments arranged in a complete randomized block design where each treatment was replicated three times with two transplants for each replicate. Regarding the foliar spray solutions with some nutrition elements were periodically sprayed at one month interval beginning from mid- March until mid September. The abovementioned saline solution was prepared as shown in Table (2).

Salts added in grams were estimated as anhydrous form.

*SAR = Meq

$$\frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

Methodology as has been followed in this investigation is being determined as follows:

Table (2): Preparation of saline solution used.

	Saline solution (6000 ppm SAR6 high Cl)		
Salt added per liter	**$CaCI_2$**	**g**	**1,67**
		meq.	**30,00**
	$MgSO_4$	**g**	**0,60**
		meq.	**10,00**
	KCI	**g**	**0,44**
		meq.	**5,84**
	K_2SO_4	**g**	**1,65**
		meq.	**8,96**
	Na_2SO_4	**g**	**0,45**
		meq.	**6,34**
	NaCI	**g**	**1,20**
		meq.	**20,51**
	SAR*		**6,00**
	Cl meq./L		**56,35**
	SO_4 meq./L		**35,29**
	Cl / SO_4 ratio		**1,60**

Morphological characteristics (vegetative growth measurements):

On mid week of October during both seasons as the experiment was ended, the effect of the different studied treatments on some vegetative growth measurements were evaluated by the following growth parameters: Stem height (cm), Stem diameter (mm.), Root length (cm), Number of branches per plant, Number of leaves per plant and Dry weights of plant organs (leaves, stems and roots in gm).

Transplants of each replicate were carefully taken out from pots then washed with tap water and followed by distilled water to free them any residues. Thereafter, each transplant was divided individually into its three organs (leaves, stem and root) to be air dried in an electrical oven at 70 °C. until a constant weight then weighed then as average dry weight for each plant organ for every replicate was estimated and recorded.

Leaf physiological characteristics:

Determination of leaf osmotic pressure (in bar).

Adequate leaf samples were immediately frozen, the cell sap was extracted in the laboratory with a piston pressure. When the frozen tissue has been thawed. The sap total soluble solid (TSS) was determined by refractometer and the equivalent values of the osmotic pressure (in bars) were estimated according to Gusov (1960).

Leaf succulence grade (L.S.G.).

Leaf succulence grade (L.S.G.) was calculated as gms. H_2O/cm^2 of leaf according to the following equation according to Nomir (1994).

$$\text{L.S.G.} = \frac{\text{Leaf water content (gm.)}}{\text{Leaf area } (DC^2)}$$

Whereas, leaf water content (gm) =

$$\frac{\text{Fresh weight} - \text{dry weight of the leaves}}{\text{Number of leaves}} \times 100$$

Leaf relative turgidity (L.R.T.).

Discs of about one cm. in diameter were removed from each leaf sample to determine their fresh weight immediately, then placed in a closed containers (Petri dishes) until they became constant in weight (after 24 hours) at room temperature 22 ± 2° in shade. The discs were surface dried with paper and weighed for their turgid weight. Dry weight of each ten discs was determined after 24 hours. Leaf relative turgidity was estimated according to the following equation described by Nomir (1994):

$$\text{L.R.T.} = \frac{\text{Fresh weight} - \text{dry weight}}{\text{Turgid weight} - \text{dry weight}} \times 100$$

Leaf water potential (L.W.P.):

The method and the equation for the calculations have been suggested by Nomir (1994).

$$\text{(L.W.P.)} = \frac{\text{Fresh weight} - \text{dry weight}}{\text{Fresh weight}} \times 100$$

Chemical analysis:

In this regard, leaf photosynthetic pigments (chlorophylls A, B and carotenoids), leaf proline content and leaf mineral composition as well as shoot content of total carbohydrates in response to different studied treatments included were concerned.

Leaf photosynthetic pigments determination:

The quantitative analysis of photosynthetic pigments in response to treatments under study were determined and calculated according to the methods described by A.O.A.C. (1990).

Leaf proline content:

The proline content was estimated in fresh leaves according to the method described by Batels *et al.*, (1973) and confirmed by Draz (1986).

Estimation of total carbohydrates:

Total carbohydrates in dry shoots (0.1 gm) were determined photometrically at 490 μm., according to the method described by the method of A.O.A.C. (1990).

Determination of leaf minerals content:

At last week of October in both seasons samples were collected and cleaned from adherent dust and dried at 70^o C for 72 hours, ground to fine powder and digested according to Chapman and Pratt, (1961). The ground dried materials of leaf samples were analyzed for total nitrogen, phosphorus, potassium, sodium, iron, manganese and zinc by the method of A.O.A.C, (1990).

- Statistical analysis:

All data obtained during each season of this study were subjected to statistical analysis according to the method described by Snedecor and Cochran (1980). However, means values for every studied parameter were compared according to the Duncan's multiple range test (Duncan, 1955).

3. Results

Growth measurements:

Stem diameter, length of (stem and root); number of (branches & leaves per plant); average leaf area; fresh and dry weights of different plant organs (leaves, stem and root) were investigated regarding their response to the treatments.

Regarding the effect of sprayed nutrient elements, results in Tables (3, 4, 5 and 6) declared that, all investigated growth measurements of the salinity stressed transplants were significantly increased by any of three nutrient elements however, Zn at 50 ppm foliar spray proved to be the most effective in this regard followed in a descending order by K and P each at 250 ppm foliar spray during two seasons of study.

Leaf physiological properties:

Four physiological characteristics (leaf water potential; leaf osmotic pressure; leaf relative turgidity and leaf succulence grade) were investigating regarding their response to effects of sprayed three nutrient elements (Zinc, Potassium and Phosphorus).

With regard to effect of sprayed three nutrient elements (Zinc, Potassium and Phosphorus), data in Table (7) revealed that, two conflicted trends were detected. Herein, leaf succulence grade, leaf water potential and leaf relative turgidity were significantly increased by any of three nutrient elements sprayed, but Zn foliar spray was more effective for (leaf water potential and leaf relative turgidity) and K spray showed the greatest increase in leaf succulence grade. On the contrary, the trend of response for leaf osmotic pressure as influenced by three nutrient elements (Zn, K and P) spray took the other way around; where characteristic was significantly decreased by any foliar application.

Chemical composition:

Photosynthetic pigments:

Leaf chlorophyll (A & B) and carotenes contents of salt stressed pear rootstock in response to effects of sprayed with nutrient elements were investigated.

The obtained results and tabulated in Table (8) revealed that, both (K and P) foliar spray each at 250 ppm and Zn at 50 ppm increased three photosynthetic pigments, while Zn foliar spray was more effective descendingly followed in this respect by (K and P) foliar spray during the study.

Stem total carbohydrates:

As for the effect of sprayed nutrient elements (Zn, K and P), it is quite clear that, total carbohydrates was increased. Zn foliar spray at 50 ppm was more effective followed in a descending order by K and/or P each at 250 ppm as increase in total carbohydrates (Table, 9).

Leaf proline contents:

With regard to effect of Zn, K and P sprays reduced significantly proline; however, Zn foliar spray was statistically the most depressive in this concern during the study (Table, 9).

Leaf mineral composition:

In this regard, effects of sprayed nutrient elements on leaf (N, P, K, Na, Fe, Mn and Zn) contents of salt stressed pear rootstock transplants were investigated. As for the effect of sprayed nutrient elements on leaf mineral composition of salt stressed pear transplants, data obtained in Tables (10 and 11) revealed obviously that, the response varied from one element to another. Foliar spray with Zn and K as well as P solely increased leaf N, P, K, Fe; Mn and Zn contents, but decreased leaf Na contents.

Table (3): Effect of some nutrient elements on some growth measurements of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Stem height (cm)		Root length (cm)		Stem diameter (cm)	
	2008	2009	2008	2009	2008	2009
Tap water (control)	155.90 A	151.20 A	69.33 A	71.66 A	0.74 A	0.71 A
Saline water(6000/6/H)	81.22 D	78.36 C	33.66 D	33.17 D	0.45 C	0.43 E
Saline water(6000/6/H) + Zn at 50 ppm	90.19 B	86.47 B	42.57 B	41.67 B	0.70 A	0.63 B
Saline water(6000/6/H) + K at 250 ppm	88.33 BC	85.49 B	41.19 BC	40.52 BC	0.57 B	0.59 C
Saline water(6000/6/H) + P at 250 ppm	86.61 C	84.48 B	38.56 C	38.47 C	0.48 C	0.48 D

Means followed by the same letter are not significantly different at 5% level

Table (4): Effect of some nutrient elements on some growth measurements of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	No. of branches/plant		No. of leaves/plant		Leaf area (cm^2)	
	2008	2009	2008	2009	2008	2009
Tap water (control)	10.00 A	9.33 A	157.80 A	155.30 A	42.18 A	42.68 A
Saline water (6000/6/H)	6.33 D	5.33 D	66.80 E	65.33 D	22.67 E	22.88 D
Saline water (6000/6/H) + Zn at 50 ppm	9.33 AB	8.67 A	78.67 B	77.67 B	26.33 B	24.64 B

Saline water (6000/6/H) + K at 250 ppm	**8.33 BC**	**7.33 B**	**75.33 C**	**75.33 C**	**25.76 C**	**23.88 C**
Saline water (6000/6/H) + P at 250 ppm	**7.33 CD**	**6.33 C**	**74.33 D**	**74.00 C**	**24.39 D**	**22.58 D**

Means followed by the same letter are not significantly different at 5% level

Table (5): Effect of some nutrient elements on fresh weight (F.W.) of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Leaves F.W. (gm)		Stem F.W. (gm)		Roots F.W. (gm)		Total plant F.W. (gm)	
	2008	2009	2008	2009	2008	2009	2008	2009
Tap water (control)	42.42 A	41.31 A	97.75 A	82. 85 A	83.95 A	81.90 A	224.10 A	205.80 A
Saline water (6000/6/H)	17.14 D	17.88 D	38.68 D	37.41 D	32.60 C	34.40 D	88.41 D	89.69 E
Saline water (6000/6/H) + Zn at 50 ppm	25.54 B	24.52 B	48.57 B	47.61 B	44.23 B	47.41 B	118.30 B	119.50 B
Saline water (6000/6/H) + K at 250 ppm	24.26 B	23.13 B	45.78 BC	44.88 BC	43.46 B	44.71 C	120.20 B	112.70 C
Saline water (6000/6/H) + P at 250 ppm	22 .68 C	21 .42 C	43.76 C	42.67 C	42.58 B	43.66 C	109.00 C	107.80 D

Means followed by the same letter are not significantly different at 5% level

Table (6): Effect of some nutrient elements on dry weight (D.W.) of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Leaves D.W. (gm)		Stem D.W. (gm)		Roots D.W. (gm)		Total plant D.W. (gm)	
	2008	2009	2008	2009	2008	2009	2008	2009
Tap water (control)	11.53 A	11.25 A	35.16 A	31.77 A	36.19A	35.30A	82.88 A	78.32 A
Saline water (6000/6/H)	7.87 C	7.11 D	18.16 C	17.55 D	15.14C	16.03C	41.17 C	40.69 C
Saline water (6000/6/H) + Zn at 50 ppm	9.50 B	9.72 B	22.81 B	22.46 B	19.15 B	20.44 B	51.46 B	52.62 B
Saline water (6000/6/H) + K at 250 ppm	9.02 B	8.19 C	21.50 BC	21.07 BC	18.82 B	19.28 C	49.34 B	48.54 B
Saline water (6000/6/H) + P at 250 ppm	8.44 BC	7.97 CD	20.55 BC	20.23 C	18.28 B	18.82 C	47.27 B	47.02 B

Means followed by the same letter are not significantly different at 5% level

Table (7): Effect of some nutrient elements on some leaf physiological properties of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	L. O. P.		L. R. T.		L. W. P.		L. S.G.	
	2008	2009	2008	2009	2008	2009	2008	2009
Tap water (control)	11.73 E	11.73 E	57.29 A	57.46 A	73.39A	72.43A	1.577A	1.569A
Saline water (6000/6/H)	19.83 A	19.83 A	23.16 E	23.42 E	54.31 D	52.83 D	1.558 D	1.456 C
Saline water 6000/6/H) + Zn at 50 ppm	12.62 D	12.62 D	29.43 D	28.51 D	61.01C	59.88C	1.565C	1.552B
Saline water (6000/6/H) + K at 250 ppm	14.88 B	14.88 B	39.57 B	39.33 B	68.52B	67.78B	1.570B	1.564B
Saline water (6000/6/H) + P at 250 ppm	14.26 C	14.26 C	32.65 C	33.17 C	61.00C	59.87C	1.563C	1.554B

Means followed by the same letter are not significantly different at 5% level

Table (8): Effect of some nutrient elements on leaf photosynthetic pigments content of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Chlorophyll (A)		Chlorophyll (B)		Carotene	
	2008	2009	2008	2009	2008	2009
Tap water (control)	1.33 A	1.16 A	1.41 A	1.39 A	1.01 A	0.98 A
Saline water (6000/6/H)	0.58 D	0.51 D	0.77 D	0.75 D	0.78 C	0.76 E
Saline water (6000/6/H) + Zn at 50 ppm	0.86 B	0.77 B	0.93 B	0.96 B	0.91 B	0.92 B
Saline water (6000/6/H) + K at 250 ppm	0.74 C	0.72 BC	0.93 B	0.86 C	0.87 B	0.87 C
Saline water (6000/6/H) + P at 250 ppm	0.62 CD	0.65 C	0.79 C	0.78 D	0.79 C	0.78 D

Means followed by the same letter are not significantly different at 5% level

Table (9): Effect of some nutrient elements on leaf carbohydrates and praline content of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Carbohydrate		praline	
	2008	2009	2008	2009
Tap water (control)	39.42 A	38.16 A	0.13 D	0.13 D
Saline water(6000/6/H)	19.97 E	18.52 E	0.39 A	0.40 A
Saline water(6000/6/H) + Zn at 50 ppm	31.58 B	28.56 B	0.20 C	0.21 C
Saline water(6000/6/H) + K at 250 ppm	25.33 C	25.11 C	0.29 B	0.30 B
Saline water(6000/6/H) + P at 250 ppm	23.13 D	21.73 D	0.29 B	0.29 B

Means followed by the same letter are not significantly different at 5% level

Table (10): Effect of some nutrient elements on leaf N,P,K and Na content of communis pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Sodium (%)	
	2008	2009	2008	2009	2008	2009	2008	2009
Tap water (control)	2.67 A	2.61 A	0.24 A	0.23 A	2.16 A	2.25 A	0.24 E	0.24 E
Saline water (6000/6/H)	1.20 D	1.18 D	0.11 B	0.12 D	0.91 C	0.74 C	0.55 A	0.62 A
Saline water (6000/6/H) + Zn at 50 ppm	1.68 B	1.52 B	0.12 B	0.12 D	0.85 E	0.71 C	0.33 C	0.35 D
Saline water (6000/6/H) + K at 250 ppm	1.43 C	1.34 C	0.12 B	0.14 C	1.57 B	1.43 B	0.38 C	0.39 C
Saline water (6000/6/H) + P at 250 ppm	1.10 D	0.86 E	0.23 A	0.21 B	0.87 D	0.74 D	0.41 B	0.42 B

Means followed by the same letter are not significantly different at 5% level

Table (11): Effect of some nutrient elements on leaf Fe, Mn and Zn content of beachifolia pear rootstock transplants irrigated with saline water during 2008 and 2009 seasons.

Treatments	Iron (ppm)		Manganese (ppm)		Zinc (ppm)	
	2008	2009	2008	2009	2008	2009
Tap water (control)	126.60 A	127.10 A	52.43 A	55.69 A	29.37 A	28.59 A
Saline water (6000/6/H)	57.69 D	55.53 C	29.23 CD	31.07 C	15.65 C	14.39 D
Saline water(6000/6/H) + Zn at 50 ppm	69.51 B	67.38 B	34.54 B	35.18 B	20.31 B	19.43 B
Saline water (6000/6/H) + K at 250 ppm	50.14 E	50.18 D	19.76 C	31.31 C	16.11 C	15.13 C
Saline water (6000/6/H) + P at 250 ppm	61.48 C	57.44 C	28.56 D	31.11 D	15.17 C	14.61 D

Means followed by the same letter are not significantly different at 5% level

4. Discussions

Zn stimulated cell elongation by encouraging cell walls to stretch (Nason, 1950), as a result of its function for process of tryptophan biosynthesis, the precursor of the IAA plant auxin. Bouat *et al*., (1954) showed that, there was a continuous demand for phosphorus for best vegetative growth of Arbequine olive. Also, Miller and Deidda, (1975) demonstrated that some parameters of young olive trees were positively affected by phosphorus application.

On the other words, potassium not only ameliorated the harmful effect of salinity, but also encouraged the vegetative growth of the pear rootstock. Huffaker and Wallace (1966) found that, the high rate of K fertilizer prevent the absorption of Na by plants to which Na is not a nutritive element by plants that need a high ratio of (Ca + Mg) : (K +Na) in the nutritional requirements.

Moreover, Rajput *et al*., (1976) on mango trees who found that spraying $ZnSO_4$ at 0.2- 0.8% in January increased length of the terminal shoot. In addition, Khamis *et al*., (1985) on grape rooted cuttings and Osman (2005) on some apple rootstocks reported that, spraying saline stressed with P or K reduced the salinity damage and improved growth.

The present results pertaining the response to foliar sprays with some nutrient elements findings Omar (1996) on mango and apricot plants, Abd- El-Mageid (1998) on almond seedlings, Hasan (2005) on olive transplants and Osman (2005) on some apple rootstocks transplants gave a real support in this regard.

These results regarding the influence of nutrient elements and growth retardants application on leaf photosynthetic pigments of salt stressed transplants are in accordance with those found by Kucherova *et al*., (1979); Nomir and El-Deeb (2000) and Gowda (2002), all reported that, nutrient elements and growth retardants increased foliar pigments contents i.e., chlorophyll (A & B) and carotenoids compounds.

The present result regarding the response of total carbohydrates was in harmony with that found by Gowda (2002).

The present result regarding the effect of nutrient elements on leaf proline contents goes in line with those found by Anju-Thakur and Singh (1998).

Such results are in general agreement with finding of Khamis *et al.*, (1985) on Thompson and American grape rooted cuttings who found that, P foliar spray caused significant decrease in leaf N and K content and increased significantly leaf P, Fe and Mn content over that of salinity stressed rooted cuttings.. However, K foliar spray increased leaf – N content. In addition, Behairy *et al.*, (1985) reported that, foliar spray with Zn increased leaf N, Fe and Mn content and decreased leaf P and K content of salt stressed transplants. Also, Omar, (1996) on mango and apricot plants and Abd- El- Mageid, (1998) on almond seedlings gave a real support in this regard.

5. Conclusion:

Foliar spray Beachilyfolia pear transplants with Zn at 50 ppm caused a significant increase of some growth measurements, leaf photosynthetic pigments content (chlorophyll A, B and carotenoids), leaf mineral content (N, P, K, Na, Fe Mn and Zn), Physiological properties (leaf succulence grade, leaf water potential and leaf relative turgidity) of beachilyfolia pear rootstock transplants. On the contrary, leaf sodium and proline contents and leaf osmotic pressure took the other way around during the study.

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11/2/2010