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ALLEVIATING THE ADVERSE EFFECTS OF WATER SALINITY ON GROWTH AND WATER CONSUMPTION OF 'LE-CONTE' PEAR TRANSPLANTS BY USING SITOFEX (CPPU) AND SOME PEAR ROOTSTOCKS

A. M. K. Abdel Aal
Hort. Dept. Fac. Agric., Minia Univ., Minia, Egypt
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ABSTRACT: ***This investigation was initiated during 2006 and 2007 seasons for examining the impact of three pear rootstocks (Pyrus communis, Pyrus betulaefolia and Pyrus calleryana) and application of Sitofex (twice at 5 ppm) on counteracting the adverse effects of water salinity (50 mM NaCl) on growth, plant pigments and water consumption of the widespread pear cv. in Egypt namely Le-Conte.***

The investigated growth traits, plant pigments and water consumption were higher, however both Na and Cl in the leaves of transplants were lower in Le-Conte grafted onto Pyrus communis, P. calleryana and P. betulaefolia, in ascending order. Salinity stress caused a great reduction on shoot lenght, leaf area, plant pigments, water consumption, while was responsible for increasing chlorophyll a/b and leaf content of both Na and Cl. The more sensitive pear rootstock to salinity was Pyrus communis, while the most tolerance pear rootstocks to salt stress were P. betulaefolia and P. calleryana. These differences to salinity tolerance among the studied pear rootstocks may be mainly due to the ability of each rootstock to exclude both Na and Cl ions in the roots. Application of Sitofex treatment was beneficial in alleviating the various adverse effects of water salinity.

Selecting pear 'Le-Conte' transplants grafted onto P. betulaefolia. and P. calleryana in addition to spraying of Sitofex twice at 5 ppm was beneficial for counteracting the adverse effects of water salinity on growth and nutritional status of the transplants growing in the newly reclaimed land of Egypt, where the use of groundwater (containing high levels of salts) is dominant.

Key word: Rootstocks. Pear, Le-comte and Salimity.

INTRODUCTION

Pear is one of the most important fruit crops widely grown in temperate and sub-tropical regions of the world (Poudyal *et al*., 2008). It is considered the third of deciduous fruits and the fourth among all fruits in its global distribution (FAO, 2002). 'Le Conte' is the main pear cultivar grown in Egypt, produced as a hybrid between *Pyrus communis* X *Pyrus serotina*.

Many factors influence the growth and production of fruit trees. Some of these factors can be controlled by growers, while others cannot. After planting, care is one of the most important factors for a successful orchard

preparation. Establishing a new pear orchard, the proper choice of rootstock is as important as the choice of cultivar and site. Rootstock choice therefore, is part of the interrelated management consideration prior to planting the orchard. The most widely common rootstock for pear cultivars in Egypt is *Pyrus communis* seedlings.

Water supply availability varies between the different horticultural regions from being plentiful to limited or scarce. However, regardless of whether water supply is abundant or low, it makes sense to use only the amounts of water needed for actual grow of a particular crop. Extra water will drain below the root zone and can be lost and potentially contaminate the groundwater.

Nowadays, the use of groundwater (containing high levels of salts) for irrigation in the newly reclaimed lands of Egypt has become a necessity due to the scarcity of water sources of good quality in such areas. This is a big problem especially with the continuous expansion in the cultivation of most commercial crops, such as pear, in the newly reclaimed lands where irrigation is a limiting factor for producing the maximum yield. However, the use of saline water for irrigation requires an adequate understanding of how salts affect soil characteristics and plant performance.

Salinization of land has been received more attention because of increasing progressively throughout the world. It is estimated that approximately a third of the world's irrigated lands and half the lands in semiarid and costal regions are affected by salinization and 10 Mha irrigated lands are abandoned annually because of excessive salinity (Kozlowski, 1997).

Soil salinity is a major problem for all agriculture crops. In low to moderate concentrations, it mainly reduces growth due to its osmotic effect (Munns and Termaat, 1986). At higher concentrations, salt may accumulate in the leaves to a toxic level, resulting in 'scorching' or 'firing' of leaves (Storey and Walker, 1999). Salinity might cause a crop to be lost due to yield loss (reduction in size, quality, etc.) or death of the plants (Raveh and Levy, 2005). Accumulation of salts in root zone affects plant performance through the development of a water deficit and the disruption of ion homeostasis (Munns, 2002). These stresses change hormonal status and impair basic metabolic processes (Loreto *et al*., 2003) resulting in inhibition of growth and reduction in yield (Paranychianakis and Chartzoulaki, 2005). High salinity in irrigation water not only reduces water uptake and tree growth, but also can cause nutritional imbalances and toxicity effects of specific ions (Syvertsen and Yelenosky 1988). The major saline ions, Na and Cl, can affect nutrient uptake through competitive interactions or by affecting the ion selectivity of membranes (Garcia-Sanchez *et al*., 2002). Hence, it should be found an effective way to use saline lands.

One way of improving the salt-tolerance is to graft scions onto salt tolerant rootstocks (Garcia-Sanchez *et al*., 2002). Rootstocks differ in their

salinity tolerance as judged by the ability to inhibit the accumulation of Cl and/or Na in leaves of the scion (Storey and Walker, 1999).

Pear rootstocks affect the nutritional status of the scion (Woodbridge, 1973) and proper choice of rootstocks can ameliorate the detrimental effects of salinity (Francois and Maas, 1994). Such salt-tolerant rootstocks may be useful for cultivation, but detailed information is currently limited (Okubo and Sakuratani, 2000).

An alternative strategy to ameliorate the adverse effects of salinity on plants is plant growth regulator, such as the cytokinin diphenylurea CPPU (El-Keltawi and Croteau, 1987).

Therefore, the present work was conducted to compare two Asian pear rootstocks i.e. *Pyrus betulaefolia* and *Pyrus calleryana* with the common European used rootstock in Egypt, *Pyrus communis* in combination with cytokinin treatment on salinity tolerance, growth and water consumption rate of 'Le Conte' pear plants grown under high level of NaCl.

MATERIALS AND METHODS

The experiment was conducted on one-year-old 'Le Conte' pear transplants grafted onto three Pyrus rootstocks (the first factor) i.e. (a_1) *P. communis*, (a_2) *P. betulaefolia* and (a_3) *P. calleryana*. They were obtained from a commercial nursery located in Shebin El-Kom, Menofia Governorate, Egypt at the last week of January of 2006 and 2007 years. The plants were transferred to the nursery of Fac. of Agric., Minia Univ. Average monthly minimum and maximum temperatures were recorded in the experimental region for each season (Table 1). Plants were watered each day with one-fourth-strength Hoagland nutrient solution (Hoagland and Arnon, 1950) for two months before the salinity treatments were initiated. Thereafter, nine uniform and vigour plants were selected for each rootstock and cultivated at the last week of March of both seasons in 10 litres plastic containers filled with quartz sand. The containers were mainly designed to determine the amount of water consumed by plants. Plants were headed back 60 cm above the ground level at planting. Containers were covered with pebbles and plastic sheet containing hole in the center surrounding the stem of the plant to prevent sand from crusting and to minimize evaporation. All pots were provided with 25 cm plastic hose. These hoses were fixed at the lower base of their walls for facilitating drainage. The fixed end of the hose was covered (inside the container) with muslin piece for preventing loss of sand with the drained water. All containers contained the same amount of sand (16.0 kg) and plants were cultivated at uniform depth.

For conducting the second factor (B) transplants of each rootstock were daily fertigated with two liters of one-fourth-strength Hoagland nutrient solution either alone as a control (b_1), containing 50 mM NaCl as salt stress treatment (b_2) or containing 50mM NaCl plus foliar application of Sitofex (N-(2-chloro-4-pyridyl)-N-phenylurea, Forchlorfenuron, KT-30, CPPU) as

cytokinin treatment to stressed plants (b_3). All treatments were started at the first week of April and continued for seven months (till the last week of October), in both seasons. Therefore, the experiment included nine treatments. Each treatment was replicated three times, three transplants per each.

Table (1): Average monthly minimum and maximum temperatures of the experimental region.

Months	2006		2007	
	Min.	Max.	Min.	Max.
April	13	29	13	30
May	18	33	17	33
June	22	35	21	36
July	21	36	22	36
August	21	35	23	36
September	19	34	21	35
October	17	31	16	29

Sitofex was sprayed twice at 5.0 ppm, once in the first week of April and again at the first week of May. Plants of the other treatments were sprayed with water in the same time of Sitofex treatment.

Daily water consumption of the plants was determined by measuring the differences of nutrient solution before and after watering. Therefore, a known volume (two liters) of the nutrient solution of each treatment was added to the plant and the hose hole was closed to prevent drainage by raising it vertically and fixing it under the container hand or by the help of clothespins for 5-7 minutes. Thereafter, the drainage water was allowed by lowering hoses again into the receiving bottles. Also, one container filled with the same amount of soil and left without plant was involved in this experiment for knowing the amount of water used by any other factors than plants. Water consumption was measured every day throughout the experiment period; therefore, it was easy to determine both monthly and yearly water consumption rates as well as the average daily water consumption per month.

At the last week of October in both seasons, the following parameters were also determined:

New shoot length (cm): The longest five shoots of each plant were measured and the average shoot length was calculated.

Leaf area (cm^2): Five leaves from each measured shoot in the previous determination, i.e. 25 leaves, were taken from the middle of these shoots and their width and length were measured in cm for the determination of the average leaf area according to the following equation given by Ahmed and Morsy (1999): Leaf area (cm^2)= 0.73 (L x W) + 0.16, where L is the maximum

leaf length and W is the maximum leaf width.

Leaf Chlorophyll content: The fresh leaves of the previous measurement were taken for the determination of chlorophyll a and b according to the methods outlined by Armitage and Carlson (1981) and expressed in mg /100g fresh weight. Total chlorophyll and chlorophyll a/b ratio were also calculated.

Plant biomass: All plants were carefully taken out from the containers, then properly washed and separated into shoots (all parts above the ground level, stems and leaves) and roots. All components were cut into small pieces and oven dried at 75°C up to a constant weight. The total dry weight (g) of each plant was calculated from the sum of the total shoots and root dry weights. Root /shoot ratio was also calculated.

Na and Cl concentrations: Leaf content of both ions was determined as percent on dry weight basis according to methods outlined by Chapman and Pratt (1961) and Wilde *et al*., (1985).

The experiment was set up in completely randomized design in a split-plot arrangement with three replicates, where the three rootstocks occupied the main-plots and the sub-plots were assigned to the other three tested treatments. All the obtained data were tabulated and statistically analyzed using new L.S.D at 5 % probability to make all comparisons among the different treatment means (According to Gomez and Gomez , 1984).

RESULTS AND DISCUSSION

1-Shoot length and leaf area

Regardless of the treatment used, it seemed that 'Le-Conte' pear transplants grown on *P. betulaefolia* and *P. calleryana* are more vigorous than those grown on *P. communis* rootstock, due to their promoting effect on shoot length and leaf area, in both seasons. The highest shoot length was Table (2) recorded on plants grown into *P. betulaefolia* rootstock. This means that *P. betulaefolia* and *P. calleryana* rootstocks were benefit when soils are poor or in replant situations where low tree vigor becomes a problem as has been reported by Stibbens (1988).

Both shoot length and leaf area of 'Le-Conte' pear plants were reduced due to salinization treatment. The severe reduction was greatly related to the tested rootstocks. The highest reduction was found on plants grown into P. *communis* followed by *P. calleryana* while the lowest reduction was obtained with *P. betulaefolia* rootstock. The reduction in leaf area was more severe than that happened in shoot length, in both seasons.

The differences in response between pear rootstocks to salinity tolerance were also recorded by Okubo and Sakuratani (2000) and Okubo *et al*., (2000). They reported that all scions grafted onto *P. betulaefolia* rootstock grew well even under 50 mM NaCl irrigation, while those grafted onto P. pyrifolia suffered heavily from NaCl stress. Also, Eissa *et al*., (2007) reported that salt tolerance of *P. betulaefolia* rootstock was higher than that of *P. communis* as ‘Le-Conte’ pear plants on *P. betulaefolia* rootstock grew better.

Table 2

The decline in leaf growth is the earliest response of glycophytes exposed to salt stress (Munns and Termaat, 1986). This is also caused by ion accumulation in the leaves, particularly the old ones (Greenway and Munns, 1980).

Treatment of CPPU improved both shoot length and leaf area of all plants grown under salinity stresses. The best improvement was recorded in plants grown into *P. betulaefolia* rootstock, in both seasons. Stressed plants treated with CPPU produced almost similar results to those of control plants, only when they grown onto *P. betulaefolia* rootstock. Applying CPPU to salinized plants of other rootstocks gave better results than those grown under salinity stress alone. Also, cytokinin treatment resulted in better improvement with *P. calleryana* than with *P. communis* rootstock, in both seasons.

The stimulative effect on plant growth due to foliar application of the cytokinin diphenylurea (CPPU) under salinity conditions was also reported by El-Keltawi and Croteau, (1987). CPPU was also very suitable to induce shoot formation (Guo *et al*., 2005). CPPU may influence shoot length by stimulating the biosynthesis of native cytokinins or other plant growth promoter hormones as reported by Ku and Woolley, (2006).

2-Dry matter accumulation

The reduction of general growth aspects due to high salinity level was associated with decreasing whole plant biomass of all tested rootstocks. Under stress treatment, dry matter was greatly varied among rootstocks Table (3). Plant biomass reduction was highest with *P. communis* rootstock, while the lowest reduction was noticed with *P. betulaefolia* rootstock. The above ground part of the plant (shoot plus leaves) was more affected under salinity stress than that of root, resulting in high root/shoot ratio. Therefore, high NaCl salinity in pear may alter the pattern of dry matter distribution favoring the root, as was also found in olive (Chartzoulakis *et al*., 2002).

The reduction in growth aspects under salinity stress, in particular in leaf area growth, resulted in low dry matter production due to low photosynthetic rates as has been reported by Chartzoulakis *et al*., (2002). This is also reflected from the negative effects of salinity on leaf chlorophyll content. The decrease in plant biomass in salinity treatments may also be caused by an increase of respiration (Ruiz *et al*., 1997) or due to low water potential, specific ion toxicity and ion imbalance (Greenway and Munns, 1980).

Sitofex treatment improved plant biomass production of plants grown under stress conditions. The best improvement was recorded from plants grafted onto *P. betulaefolia* rootstock, in both seasons. CPPU caused an increase in the allocation of assimilates and induced higher dry matter accumulation (Famiani *et al*., 1998).

Table 3

3- Leaf chlorophyll content

At the end of the experiment, in both seasons (Table (4 and 5), leaves of unsalinized plants showed higher contents of chlorophyll than those of salinized plants. Leaf chlorophyll contents differed considerably among rootstocks. The decrement of chlorophyll a and b due to salinity stress was greatly suppressed with *P. communis* rootstock.

Cholorophyll a, was less affected with salinity than chlorophyll b, resulting in an promotion on Chl a/b ratio. Similar results have been shown by Kaya *et al*., (2002) for strawberry and Morsy (2003) for mango plants.

The effect of salinity in reducing chlorophyll of leaves could be attributed to its effect on activating chlorophyllase enzyme (Sivtsev *et al*., 1973). This also may caused by its depressive effect on the absorption of some ions which are involved in the chloroplast formation, such as Mg and Fe (Hanafy *et al*., 2002).

Foliar application of CPPU to salinized plants greatly improved leaf content of both types of chlorophylls. The best results were obtained with *P. betulaefolia* followed by *P. calleryana* and finally with *P. communis* rootstock. CPPU treatment was found to be effective in improving leaf content of total chlorophyll (Caboni *et al.,* 2007).

4- Leaf content of Na and Cl

In the presence of NaCl in the root zone, both Na and Cl concentrations were increased in leaves of salt stressed seedlings compared with the control. Accumulation of Na and Cl in the leaves of salt stressed plants was extremely differed among rootstocks Table (6). Plants on *P. betulaefolia* accumulated less Na and Cl on their leaves than those of other rootstocks, in both seasons. Therefore, *P. betulaefolia* rootstock may have the ability to partially exclude Na and/or Cl from the cytoplasm at the root level as has been reported by Okubo and Sakuratani, (2000). However, Na and Cl accumulation in the leaves of salt stressed seedlings on *P. communis* was remarkably high. This indicates it's highly sensitive to salinity stress.

In citrus rootstocks, Cleopatra (in contrast to Carrizo), accumulated more Na and Cl in roots than in shoots and was, therefore, able to avoid toxic levels of these ions in leaves of the scion (Garcia-Sanchez *et al*., 2002).

The loss of chlorophyll content could be associated with accumulation of Na and Cl in the leaves (Garcia-Sanchez *et al*., 2002). They reported that accumulations of Na and Cl in salt stressed leaves were related to reductions in leaf chlorophyll, net CO^2 assimilation rate and stomatal conductance in leaves.

Application of Sitofex (CPPU) lowered the concentration of both ions in leaf, but they remained significantly higher than in the control. The decrease of Na and Cl in leaf may partially be explained by a 'dilution effect' i.e. increased in dry matter accumulation as has been reported by Kaya *et al*., 2002 when a supplementary Ca used for ameliorating the adverse effects of

Table 4

Table 5

Table 6

NaCl stress. Munns and Termaat (1986) suggested that a larger plant mass provides more space for ion compartmentalisation and assists a plant in avoiding salt toxicity.

5- Water consumption

Regardless of the treatment used, both daily and monthly water consumption rates were at their minimum during April due to small transpiring surface areaTable (7 and 8). Thereafter, they were gradually increased reaching their maximum at July and August, in both seasons respectively. This may be due to increasing leaf area and mean day temperature. July and August afterwards, the water consumption rates were decreased slowly towards the end of growing season.

Natali *et al*., (1985) reported that average water consumption was directly related to the total leaf area of the trees. Consequently, the highest amount of water in the whole season was consumed by *P. betulaefolia*, followed by *P. calleryana* and finally *P. communis* rootstocks. Similar results were obtained by (Olien and Lakso, 1986). They explained the role of the rootstocks on water usage by their effects on the vegetative growth rate of the scion, which in turn, may caused a variation in the transpiration and stomatal conductance rates.

Results also showed that daily, monthly and yearly water consumption rates were significantly decreased in all salinized plants compared with those of unsalinized plants. The differences in water consumption rates between salinized and unsalinized plants became greater over the stress period. This indicates an apparent link between the adverse effects of salinity and time.

Lioyd *et al*., (1990) suggested that the toxic effect of the accumulated ions could be involved in the reduction of photosynthesis and stomatal conductance and this reflected in low transpiration rate and water usage.

By the latter stage of the experiment, the salinized plants have a much lower biomass and leaf area, which probably accounts for much lower water use as has been explained by (Kaya *et al*., 2002).

Similar results were also obtained by (Syvertsen and Yelenosky, 1988). They noted that high salinity in irrigation water resulted in much decrement of water uptake by plants.

The CPPU treatment resulted in better improvement on water consumption rates by all stressed plants, in particular, plants of *P. betulaefolia* rootstock. This indicated that CPPU treatment is required for counteracting the adverse effects of salinity on water use by stressed plants and consequently, better growth will be achieved under these conditions.

Table (7

Table (8

CONCLUSION

1-Both *P. betulaefolia* and *P. calleryana* rootstocks are more vigorous for 'Leconte' pear plants than *P. communis* rootstock, and this may be required under poor conditions of sandy soils.

2-Differences between rootstocks in salinity tolerance may be attributed to the ability of each rootstock to exclude both Na and Cl ions.

3-To obtain good water consumption rates and consequently, better growth characters for stressed plants, it is recommended to apply two sprays of Sitofex (CPPU) at 5 ppm during the first week of both April and May, in particular, with *P. betulaefolia* rootstock. This treatment resulted in values very close to those of unstressed plants.

REFERENCES

Ahmed, F.F. and M.H. Morsy (1999). A new method for measuring leaf area in different species. Minia J. of Agric. Res. and Develop.19: 97-105, Egypt.

Armitage, A.M. and W.H. Carlson (1981). The effect of quantum flux density, day and night temperature and phosphorus and potassium on anthocyanin and chlorophyll content in marigold leaves. J. Amer. Soc. Hort. Sci., 106: 639-642.

Caboni, E., M.G. Tonelli, R. Biasi and C. Damiano (2007). Effect of exogenous cytokinins, applied in the proliferation phase, on the rooting performance of Kiwifruit: The case of CPPU and BA. Acta Horticulturae 764: 285-288.

Chapman, H.D. and P.F. Pratt (1961). “Methods of Analysis for Soils, Plants and Waters”. Divs. Agric. Sci. Publ. Office, California Univ., Berkeley pp 201.

Chartzoulakis; K., M. Loupassaki, M. Bertaki and I. Androulakis (2002). Effects of NaCl salinity on growth, ion content and CO^2 assimilation rate of six olive cultivars. Scientia Horticulturae 96: 235–247.

Eissa, F.M., M.A. Fathi and S.A. El-Shall (2007). The role of humic acid and rootstock in enhancing salt tolerance of "Le-Conte" pear seedlings". J. of Agric. Sci., 32 (5): 3651 – 3666.

El-Keltawi, N.E. and R. Croteau (1987). Salinity depression of growth and essential oil formation in spearmint and marjoram and its reversal by foliar applied cytokinin. Phytochemistry 26 (5):1333-1334.

Famiani, F., E. Antognozzi, A. Tombesi, S. Moscatello and A. Battistelli (1998). CPPU induced alterations in source-sink relationships in A*ctinidia deliciosa*. Acta Hort. (ISHS) 463:306-310.

F.A.O. (2002). Food and Agriculture Organization Production Year Book. Vol. 61, Washington, D.C.

Francois, L.E. and E.V. Maas (1994). Crop response and management on salt-affected soils. In: Pessarakli, M. (Ed.), Handbook of Plant and Crop Stress. Marcel Dekker, New York, pp. 149-181.

Garcia-Sanchez, F., J.L. Jifon, M. Carvajal and J. Syvertsen (2002). Gas exchange, chlorophyll and nutrient contents in relation to Na and Cl

accumulation in 'Sunburst' mandarin grafted on different rootstocks. Plant Science 162: 705-712.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons- New York, USA pp. 680.

Greenway, H. and R. Munns (1980). Mechanisms of salt tolerance in non-halophytes. Ann. Rev. Plant Physiol. 31, 149–190.

Guo, D., Z. Zhu, X. Hu and S. Zheng (2005). Effect of cytokinins on shoot regeneration from cotyledon and leaf segment of stem mustard (*Brassica juncea* var. *tsatsai*). Plant cell, Tissue and Organ Culture, 83 (1): 123-127.

Hanafy, A.H., Mervat, M. A. Gad, H. M. Hassan and Mona, A. Amin (2002). Improving growth and chemical composition of *Pyrus communis* grown under soil salinity conditions by polyamine foliar application. Proc. Minia 1st Conf. For Agric. And Environ. Sci., Minia, Egypt, March 25-28, Minia J. Agric. Res. & Develop. Sp. Issue 22 (2): 1697-1720.

Hoagland, D. R. and D.S. Arnon (1950). The water culture method for growing plants without soil. Calif. Agric. Exp. Stat. Circ. 374:1–32.

Kaya, C., H. Kirnak, D. Higgs and K. Saltali (2002). Supplementary calcium enhances plant growth and fruit yield in strawberry cultivars grown at high (NaCl) salinity. Scientia Horticulturae, 93: 65-74.

Kozlowski, T.T. (1997). Responses of Woody Plants to Flooding and Salinity, Tree Physiology Monograph No. 1. Heron Publishing Victoria, Canada, pp. 1–28.

Ku, Y.G. and D.J. Woolley (2006). Effect of plant growth regulators and spear bud scales on growth of Asparagus officinalis spears. Scientia Horticulturae, 108 (3): 238-242.

Lioyd, J., P.E. Kriedemann and D. Aspinall (1990). Contrast between Citrus species in response to salinisation: an analysis of photosynthesis and water relations for different rootstock-scion combination. Physiol. Plant 78: 236-246.

Loreto, F., M. Centritto and K. Chartzoulakis (2003). Photosynthetic limitations in olive cultivars with different sensitivity to salt stress. Plant Cell Environ. 26, 595–601.

Minia Airport Meteorological Station: Minia temperature records during 2006 and 2007 years., Egypt.

Morsy, M. H. (2003). Growth ability of mango cultivars irrigated with saline water. Acta Hort. 609: 475-482.

Munns, R. (2002). Comparative physiology of salt and water stress. Plant Cell Environ. 25, 239–250.

Munns, R. and A. Termaat (1986). Whole-plant responses to salinity. Aust. J. Plant Physiol. 13, 143–160.

Natali, S., C. Xiloyannis and A. Babieri (1985). Water consumption of peach trees grafted on four different rootstocks. Acta. Hort. (ISHS) 173: 355-362.

Okubo, M. and T. Sakuratani (2000). Effects of sodium chloride on survival and stem elongation of two Asian pear rootstock seedlings. Scientia Horticulturae 85(1-2): 85-90.

Okubo, M., Y. Furukawa and T. Sakuratani (2000). Growth, flowering and leaf properties of pear cultivars grafted on two Asian pear rootstock seedlings under NaCl irrigation. Scientia Horticulturae, 85 (1-2): 91-101.

Olien, W.C. and A.N. Lakso (1986). Effect of rootstock on apple (*Malus domestica*) tree water relations. Physiologia Plantarum 67: 421-430.

Paranychianakis, N. V. and K. S. Chartzoulakis (2005). Irrigation of Mediterranean crops with saline water: from physiology to management practices. Agriculture, Ecosystems and Environment 106: 171–187.

Poudyal, B. K., Y. Zhang and D.U. Guoqiang (2008). Adventitious shoot regeneration from the leaves of some pear varieties (*Pyrus spp.*) grown in vitro. Front. Agric. China 2 (1): 82–92.

Raveh, E. and Y. Levy (2005). Analysis of xylem water as an indicator of current chloride uptake status in citrus trees. Scientia Horticulturae 103: 317–327.

Ruiz, D., V. Martinez and A. Cerda (1997). Citrus response to salinity: growth and nutrient uptake. Tree physiology 17: 141-150.

Sivtsev, M. V., S.V. Ponamareva and E.A. Kuzmetsova (1973). Effect of salinization and herbicide on chlorophyllase activity in tomato leaves. Fiziol. Rast. 20:62.

Stibbens, R. (1988). Choosing Pear Rootstocks For The Pacific Northwest. A Pacific Northwest Extension Publication. Oregon, Idaho, Washington, US.

Storey, R. and R. R. Walker (1999). Citrus and salinity. Sci. Hort. 78, 39–81.

Syvertsen, J. P. and G. Yelenosky (1988). Salinity can enhance freeze tolerance of citrus rootstock seedlings by modifying growth, water relations and mineral nutrition. J. Am. Soc. Hort. Sci. 113: 889-893.

Wilde, S.A., R.B. Corey, J.G. Lyer and G.K. Voigt (1985). Soil and Plant Analysis for Tree Culture. pp 1-105 Oxford IBLT, New Delhi, India.

Woodbridge, C.G. (1973). Effect of rootstocks and interstocks on nutrient levels in `Bartlett' pear leaves, on tree growth and fruit. J. Am. Soc. Hort. Sci. 98, 200-202.

تخفيف حدة التأثيرات الضارة لملوحة الماء على النمو ومعدل استهلاك الماء لشتلات الكمثرى صنف ليكونت باستخدام السيتوفكس وبعض أصول الكمثرى

احمد محمد كمال عبد العال
قسم البساتين – كلية الزراعة – جامعة المنيا – مصر

الملخص العربي

تم إجراء هذه التجربة خلال موسمى ٢٠٠٦ ، ٢٠٠٧ لاختبار تأثير ثلاثة أصول من الكمثرى ***Pyrus communis*** ، ***Pyrus calleryana*** ، ***Pyrus betulaefolia*** وإضافة السيتوفكس (مرّتين بتركيز ٥ جزء فى المليون) على تقليل التأثيراتِ المعاكسةِ لملوحةِ الماءِ (٥٠ ملليمول كلوريد صوديوم) على النمو ، الصبغات النباتِية ومعدل استهلاك الماءِ لصنف الكمثرى الليكونت الأكثر انتشارا فى مصر.

أوضحت النتائج أن صفات النمو التى تم قياسها والصبغات النباتِية ومعدل استهلاك الماءِ كانت عالية، بينما كانت نسبة الصوديوم والكلوريد قليلة فى أوراق شتلات الصنف ليكونت المطعومه على ***Pyrus communis*** ،***P. calleryana*** ، ***P. betulaefolia*** مرتبة ترتيبا تصاعديا.

أحدثت الملوحة انخفاض كبير فى طول النموات، مساحة سطح الورقة، الصبغات النباتية ومعدل استهلاك الماءِ ، بينما أدت إلى زيادة نسبة كلوروفيل أ الى ب ومحتوى الأوراق من الصوديوم والكلوريد. كان أكثر أصول الكمثرى حساسية للملوحة هو أصل ***P. communis*** بينما كان *آ شلاً* ***P. betulaefolia*** ، ***P. calleryana*** الأكثر تحملا للملوحة.

هذه الاختلافات فى تحمل الملوحةِ بين أصول الكمثرى تحت الدراسة ربما راجع بشكل رئيسي الى قدرةِ كل أصل من هذه الأصول الى إبعاد ايونات الصوديوم والكلوريد في الجذورِ. إضافة معاملة السيتوفكس كانت مفيدة فى تقليل مختلف التأثيرات الضارة لملوحة الماء.

إن اختيار شتلات الليكونت المطعومه على أصلا ***P. betulaefolia*** ، ***P. calleryana*** بالإضافة الى رش السيتوفكس مرتين بتركيز ٥ جزء فى المليون كان مفيدا للحد من التأثيرات الضارة لملوحة الماء على النمو والحالة الغذائية للشتلات النامية فى الاراضى المستصلحة حديثا فى مصر الغالب فيها استخدام المياه الجوفية (المحتوية على مستويات عالية من الملوحة).

Table (2): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on shoot length (cm) and leaf area (cm^2) of Le-Conte pear transplants during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	Shoot length (cm)							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	77.10	47.10	65.70	63.30	82.60	54.20	70.97	69.26
a_2 *P. betulaefolia*	117.10	85.70	113.60	105.47	146.70	65.90	108.10	106.90
a_3 *P. calleryana*	132.20	62.73	101.40	98.78	109.77	88.20	105.00	100.99
Mean (B)	108.8	65.18	93.57		113.02	69.43	94.69	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	2.56	1.82	3.15		2.85	2.50	4.33	
	Leaf area (cm^2)							
a_1 *P. communis*	27.70	16.40	22.60	22.23	28.50	17.20	25.20	23.63
a_2 *P. betulaefolia*	31.20	22.10	28.50	27.27	30.80	23.50	30.20	28.17
a_3 *P. calleryana*	32.80	14.60	20.30	22.57	33.40	12.70	22.60	22.90
Mean (B)	30.57	17.70	23.80		30.90	17.80	26.00	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	1.79	1.37	2.37		1.47	0.85	1.47	

Table (3): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on Biomass production of Le-Conte pear transplants during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	Shoot dry weight							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	80.50	43.50	62.00	62.00	87.40	48.70	70.20	68.77
a_2 *P. betulaefolia*	105.70	82.60	102.10	96.80	135.80	58.20	86.80	93.60
a_3 *P. calleryana*	122.80	54.30	80.10	85.73	96.70	85.00	94.60	92.10
Mean (B)	103.00	60.13	81.40		106.63	63.97	83.87	
New L.S.D. at 5%	A 1.94	B 1.80	AB 3.12		A 0.49	B 1.11	AB 1.92	
	Root dry weight							
a_1 *P. communis*	24.70	15.10	20.30	20.03	20.30	17.50	23.80	20.53
a_2 *P. betulaefolia*	28.90	23.50	27.10	26.50	27.30	25.80	27.70	26.93
a_3 *P. calleryana*	30.10	18.30	24.40	24.27	32.23	17.40	22.50	24.04
Mean (B)	27.90	18.97	23.93		26.61	20.23	24.67	
New L.S.D. at 5%	A 2.08	B 0.68	AB 1.18		A 0.53	B 0.80	AB 1.38	
	Total dry weight							
a_1 *P. communis*	105.20	58.60	82.33	82.04	113.90	66.20	94.00	91.37
a_2 *P. betulaefolia*	134.60	106.10	129.20	123.3	124.00	110.80	122.30	119.03
a_3 *P. calleryana*	152.90	72.60	104.50	110.0	168.00	75.60	109.30	117.63
Mean (B)	130.9	79.10	105.34		135.3	84.2	108.53	
New L.S.D at. 5%	A 1.00	B 1.32	AB 2.28		A 1.51	B 1.26	AB 2.18	

Table (4): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on leaf chlorophyll a and b content of Le-Conte pear transplants during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	Chlorophyll a (mg /100g fresh weight)							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	132.50	92.30	122.80	115.87	140.40	98.70	128.30	122.47
a_2 *P. betulaefolia*	165.40	140.90	168.70	158.33	162.27	138.60	158.70	153.19
a_3 *P. calleryana*	154.30	96.80	115.30	122.13	158.70	93.80	123.10	125.20
Mean (B)	150.73	110.00	135.60		153.79	110.37	136.70	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.4٨	0.77	1.32		2.92	2.16	3.74	
	Chlorophyll b (mg /100g fresh weight)							
a_1 *P. communis*	35.50	15.10	24.30	24.97	37.20	15.10	21.60	24.63
a_2 *P. betulaefolia*	38.40	27.80	34.60	33.60	36.40	28.40	33.70	32.83
a_3 *P. calleryana*	33.40	16.80	26.40	25.53	32.80	18.30	28.70	26.60
Mean (B)	35.77	19.90	28.43		35.47	20.60	28.00	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.57	0.76	1.32		0.41	0.31	0.54	

Table (5): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on total chlorophyll and chlorophyll a/b ratio of Le-Conte pear transplants onto some pear rootstocks during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	Total chlorophyll (mg /100g fresh weight)							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	168.00	107.40	147.10	140.83	177.60	113.80	149.90	147.10
a_2 *P. betulaefolia*	203.80	168.70	203.30	191.93	198.67	167.00	192.40	186.02
a_3 *P. calleryana*	187.70	113.60	141.70	147.66	191.50	112.10	151.80	151.80
Mean (B)	186.50	129.90	164.00		189.26	130.97	164.70	
New L.S.D. at 5%	A 0.46	B 0.70	AB 1.22		A 3.18	B 2.21	AB 3.82	
	Chlorophyll a/b ratio							
a_1 *P. communis*	3.732	6.113	5.053	4.966	3.774	6.536	5.940	5.417
a_2 *P. betulaefolia*	4.307	5.068	4.876	4.750	4.458	4.880	4.709	4.682
a_3 *P. calleryana*	4.620	5.762	4.367	4.916	4.838	5.126	4.289	4.751
Mean (B)	4.219	5.654	4.765		4.357	5.514	4.979	
New L.S.D. at 5%	A 0.083	B 0.117	AB 0.203		A 0.137	B 0.145	AB 0.252	

Table (6): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on leaf accumulation of Na and Cl of Le-Conte pear transplants onto some pear rootstocks during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	Na %							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	0.14	0.52	0.34	0.33	0.14	0.58	0.30	0.34
a_2 *P. betulaefolia*	0.08	0.19	0.11	0.13	0.10	0.17	0.13	0.13
a_3 *P. calleryana*	0.11	0.41	0.26	0.26	0.09	0.34	0.20	0.21
Mean (B)	0.11	0.37	0.24		0.11	0.36	0.21	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.09	0.03	0.06		0.02	0.03	0.06	
	Cl %							
a_1 *P. communis*	0.26	0.73	0.57	0.52	0.24	0.84	0.51	0.53
a_2 *P. betulaefolia*	0.21	0.43	0.25	0.30	0.22	0.39	0.30	0.30
a_3 *P. calleryana*	0.22	0.64	0.41	0.42	0.21	0.55	0.38	0.38
Mean (B)	0.23	0.6	0.41		0.22	0.59	0.40	
New L.S.D. at 5%	A	B	AB		A	B	AB	
	0.04	0.06	0.10		0.02	0.03	0.06	

Table (7): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on average daily water consumption (April, May, June and July) of Le-Conte pear transplants onto some pear rootstocks during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	April							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	76.50	74.30	81.40	77.40	85.70	88.10	90.90	88.23
a_2 *P. betulaefolia*	117.70	115.40	113.50	115.53	132.00	124.90	127.20	128.03
a_3 *P .calleryana*	96.83	98.40	95.20	96.81	94.00	92.00	90.00	92.00
Mean (B)	97.01	96.03	96.7		103.9	101.67	102.7	
New L.S.D. 5%	A 0.87	B NS	AB 1.67		A 2.24	B 1.73	AB 2.99	
	May							
a_1 *P. communis*	305.00	282.00	318.00	301.67	387.40	316.00	400.20	367.87
a_2 *P. betulaefolia*	532.70	412.00	548.00	497.57	674.00	580.10	630.00	628.03
a_3 *P. calleryana*	467.70	490.50	503.50	487.23	438.10	407.00	452.30	432.47
Mean (B)	435.13	394.83	456.50		499.83	434.37	494.17	
New L.S.D. 5%	A 2.02	B 1.38	AB 2.38		A 1.31	B 0.96	AB 1.66	
	June							
a_1 *P. communis*	648.50	502.10	570.80	573.80	730.90	535.90	684.30	650.37
a_2 *P. betulaefolia*	832.30	661.90	876.10	790.10	1098.30	720.10	905.00	907.80
a_3 *P. calleryana*	906.10	631.40	766.50	768.00	791.90	680.20	780.00	750.70
Mean (B)	795.63	598.47	737.80		873.70	645.4	789.77	
New L.S.D. 5%	A 1.96	B 1.62	AB 2.81		A 3.70	B 2.92	AB 5.06	
	July							
a_1 *P. communis*	987.00	607.33	920.00	838.11	1012.20	741.13	883.10	878.81
a_2 *P. betulaefolia*	1193.50	953.50	1067.90	1071.63	1312.00	880.00	990.20	1060.70
a_3 *P. calleryana*	1283.20	716.70	850.30	950.07	1044.20	932.00	955.40	977.20
Mean (B)	1154.57	759.18	946.07		1122.8	851.04	942.9	
New L.S.D. 5%	A 1.60	B 1.11	AB 1.92		A 4.72	B 2.37	AB 4.11	

Table (8): Effect of some pear rootstocks, salinity and Sitofex (CPPU) treatments on average daily water consumption (August, September and October) of Le-Conte pear transplants onto some pear rootstocks during 2006 and 2007 seasons.

Pear rootstocks (A)	Salinity and Sitofex (CPPU) treatments (B)							
	August							
	2006				2007			
	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)	b_1 Control	b_2 Salinity	b_3 Salinity+ CPPU	Mean (A)
a_1 *P. communis*	990.00	522.00	872.00	794.67	1056.00	568.20	927.90	850.70
a_2 *P. betulaefolia*	1109.70	780.60	982.33	957.55	1384.47	706.70	972.00	1021.10
a_3 *P .calleryana*	1138.00	645.40	765.20	849.53	1086.90	822.30	988.00	965.73
Mean (B)	1079.23	649.33	873.18		1175.79	699.07	962.63	
New L.S.D. 5%	A	B	AB		A	B	AB	
	6.21	4.15	7.19		30.99	19.64	34.01	
	September							
a_1 *P. communis*	642.00	272.00	590.00	501.33	684.60	316.30	567.70	522.87
a_2 *P. betulaefolia*	874.00	632.00	760.00	755.33	846.00	688.20	751.80	762.00
a_3 *P. calleryana*	907.00	406.60	614.20	642.60	902.40	444.20	698.00	681.53
Mean (B)	807.67	436.80	654.73		811.0	482.9	672.5	
New L.S.D. 5%	A	B	AB		A	B	AB	
	4.90	5.10	8.84		2.45	4.0	6.93	
	October							
a_1 *P. communis*	489.00	120.00	387.00	332.00	524.30	177.90	401.50	367.90
a_2 *P. betulaefolia*	759.40	500.10	632.60	630.70	725.20	524.90	622.00	624.03
a_3 *P. calleryana*	803.00	148.70	438.70	463.47	804.00	156.00	420.00	460.00
Mean (B)	683.80	256.27	486.10		684.50	286.27	481.17	
New L.S.D. 5%	A	B	AB		A	B	AB	
	3.10	1.89	3.27		6.86	8.26	14.31	