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# Effect of Compost Addition to Growing Medium to Reduce the Use of Inorganic Nutrient Solution in Lettuce Production on Rooftops

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## ABSTRACT

The demand of safe agriculture products free of pesticides and chemicals is increasing every day due to increase the health awareness. Establish rooftops gardens for producing fresh vegetable crops free of pesticides and with minimum use of mineral fertilizers could be a great step in this field. On the other hand, compost provides an organic source for nutrients, so it can be used as alternative source for plant nutrients instead of inorganic nutrient solution that prepared of mineral fertilizers. For that it was important to study the effect of compost addition to growing medium and its role in reducing the use of inorganic nutrient solution. In this context, an experiment has been conducted in the rooftop garden of Central Laboratory for Agricultural Climate, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Dokki, Giza, during winter seasons of 2012 and 2013 to reduce the use of inorganic nutrient solution by compost addition in different percentages as a part of the growing medium for producing red leaf lettuce. Four percentages of compost were added to the growing medium: (zero%, 5%, 10% and 15%) with irrigation by inorganic nutrient solution adjusted at 1m.mhos$^2$ and compared them with control treatment (irrigation by inorganic nutrient solution adjusted at 2m.mhos$^2$ without compost). Different measurements have been recorded during the experimental time such as: leaves fresh weight, leaves dry weight, root fresh weight, root dry weight, dry matter percentage per plant, yield and percentages of nitrogen, phosphorus, potassium in leaves. Results illustrated that the use of compost as a part of the growing medium reduced the need of inorganic nutrient solution; the combination between compost addition by 15% to growing medium and irrigation by inorganic nutrient solution adjusted at 1m.mhos$^2$ (EC-1+15%) was the best combination between compost as a part of the growing medium and concentration of the inorganic nutrient solution for producing red leaf lettuce in comparison with control that irrigated with inorganic nutrient solution adjusted at 2m.mhos$^2$ without the use of compost as a part of the growing medium. plants grown in EC-1+15% recorded the highest values regarding leaves fresh and dry weights per plant, root fresh and dry weights per plant, yield per m$^2$, nitrogen and phosphorus percentages in leaves.

***Key words:*** Lettuce, growing medium, compost, nutrient solution, rooftops gardens.

## Introduction

The term growing medium is used to describe the materials used to grow plants in containers (Blok and Verhagen, 2009; Schroeder and Sell, 2009). A good growing media should have some characteristics such as provide aeration and water, allow for maximum root growth and support the plant (Bilderback *et al.*, 2005). Various ingredients have been used as growing media for vegetable production throughout the world. The raw materials used vary based on their local availability (Schmilewski, 2009). Such materials can be inorganic or organic, but growing media are often formulated from a mix of different materials or components in order to achieve the correct balance of air availability and water holding capacity for the plants to be grown well. Moreover, composted materials have routinely been used as a growing medium or components of growing media (Bilderback *et al*., 2005, Schroeder and Sell, 2009; Nair *et al*., 2011). Composting has been defined as a biological process through which microorganisms convert organic materials into useful end products. The solid particulate products of composting, which are extracted during the maturation and curing phase are referred to as compost (Buchanan and Gliessman, 1991; Paulin and O'Malley, 2008; Litterick and Wood, 2009). Compost can be defined as organic fertilizer produced as a result of decomposition of a wide variety of crop wastes or animal wastes or other wastes (Roy *et al*.,

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2006). Composted organic materials are being applied on agricultural fields as an amendment to provide nutrients and also to enhance the organic matter content and improve the physical and chemical properties of the cultivated soils. Composted organic materials contain essential nutrients for plant growth, especially nitrogen and phosphorus (Beltrán *et al.,* 2002). Also, Mamo *et al*., (1998) mentioned that compost addition to soil not only to increase crop yield, but also to improve soil fertility, permeability and available water capacity and air filled porosity. There is no single recommended amount of compost to be used in growing media that applies to all situations. The amount of the compost component in a growing medium depends on the type of compost, the plant species to be grown and grower cultural practices (Bunt, 1988). On the other hand, Lettuce is one of the most important vegetable crops in the world, wide spread crop, comes in different varieties. Lettuce is rich in vitamin A, C and minerals. It also contains protein and carbohydrates (Tindall, 1983). For that this experiment aimed to decrease the use of inorganic nutrient solution by compost addition to growing media for the production of lettuce on rooftops.

## Materials and Methods

An experiment has been conducted in the rooftop garden of Central Laboratory for Agricultural Climate, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Dokki, Giza, during winter seasons of 2012 and 2013 to reduce the use of inorganic nutrient solution by compost addition in different percentages to the growing medium for producing lettuce.

Red leaf lettuce was under investigation in this experiment; the red leaf lettuce is loose leaf type lettuce don't form a compact head. Seedlings have been transplanted in beds system in the first of October 2012 and replicated in the same time at 2013. Plant density was 20 plants per $m^2$. The beds system consisted of wooden table (100cm length, 100cm width, and 10cm depth) and height of table legs was 60cm from rooftop floor. Each table laid with black polyethylene sheets 0.5 mm in thickness and equipped with drainage tube in one side, also equipped with one bucket under each table to collect the excess diluted nutrient solution. The growing medium consisted of mixture of peat moss and perlite 1:1 v/v.

Different percentages of compost have been added to the growing medium and irrigated by inorganic nutrient solution adjusted at 1m.mhos$^2$, and a control treatment that contains the same growing medium without compost and irrigated with inorganic nutrient solution adjusted at 2m.mhos$^2$. Treatments description was as follow:

1. Zero% compost in the growing medium + irrigation by inorganic nutrient solution at 1m.mhos$^2$ (EC-1+zero %).
2. 5% compost in the growing medium + irrigation by inorganic nutrient solution at 1m.mhos$^2$ (EC-1+5%).
3. 10% compost in the growing medium + irrigation by inorganic nutrient solution at 1m.mhos$^2$ (EC-1+10%).
4. 15% compost in the growing medium + irrigation by inorganic nutrient solution at 1m.mhos$^2$ (EC-1+15%).
5. Zero% compost in the growing medium + irrigation by inorganic nutrient solution at 2m.mhos$^2$ (control).

Drip irrigation system have been used to deliver the diluted nutrient solution to each plant then a slope about 1% have been made for collecting the excess drained diluted nutrient solution and return it back to the catchment bucket using the drainage tube.

The nutrient solution described by (El-Behairy, 1994) was used as the inorganic nutrient solution in this experiment. Two concentrations have been used; the electrical conductivity (EC) adjusted at 1m.mhos$^2$ in four treatments and adjusted at 2m.mhos$^2$ in the control treatment. Digital EC meter was used to adjust the EC to the required levels.

Data in table (1) illustrates the chemical analysis of the compost that used in this experiment.

**Table 1:** Chemical analysis of the compost

| Macro nutrients (%) | | | | | Micro nutrients (ppm) | | | |
|---|---|---|---|---|---|---|---|---|
| N | P | K | Ca | Mg | Fe | Zn | Mn | Cu |
| 0.980 | 0.451 | 0.770 | 1.46 | 0.500 | 5690.00 | 118.20 | 56.00 | 19.80 |

Different measurements have been recorded during the experimental time such as: leaves fresh weight (g/plant), leaves dry weight (g/plant), root fresh weight (g/plant), root dry weight (g/plant), dry matter percentage per plant, yield (kg/$m^2$) and percentages of nitrogen, phosphorus, potassium in leaves.

The experiment was arranged in complete randomized blocks design with three replicates. The collected data were analyzed using ANOVA statistical analysis as described by Snedicor and Cochran, (1980) and the least significant difference (LSD) at a probability level of 5% was used in comparison among means.

## Results

### Leaves fresh weight:

Data in Fig (1) illustrates the effect of compost addition in different percentages to growing medium on leaves fresh weight of red leaf lettuce. Data collected from the first season indicated that the highest leaves fresh weight was recorded in EC-1+15% followed by control, then EC-1+10% and EC-1+ 5% respectively. While the lowest leaves fresh weight values were recorded in EC-1+zero%. Furthermore, data indicated that the difference between EC-1+15% and control was not significant, other differences among treatments were significant. Similar trends were observed in the second season except that all differences among treatments were significant.

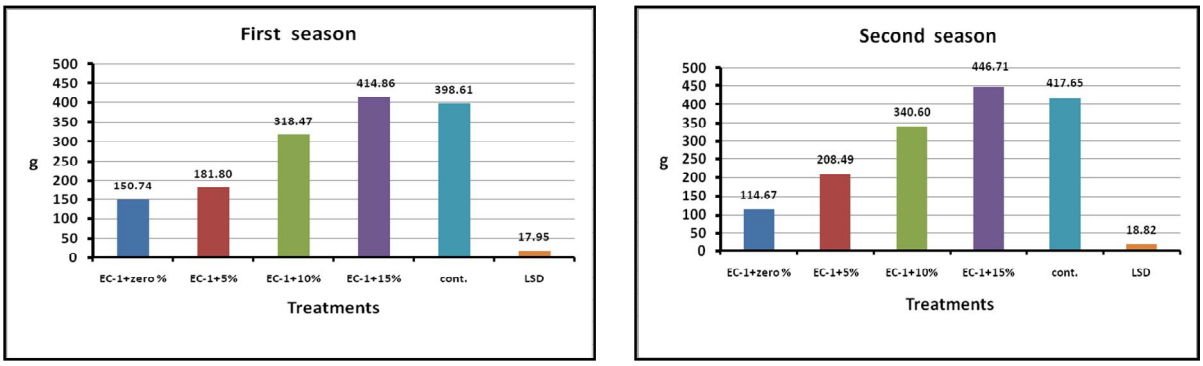


**Fig. 1:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on leaves fresh weight (g/plant) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

### Leaves dry weight:

Data in Fig (2) illustrates the effect of compost addition in different percentages to growing medium on leaves dry weight. Data collected from the first season illustrated that the highest leaves dry weight values were found in EC-1+15% then control, EC-1+10% and EC-1+5% respectively. In contrast, plants grown in EC-1+zero% recorded the lowest leaves dry weight values. Moreover, data showed that differences among treatments were significant. Similar trends were observed in the second season.

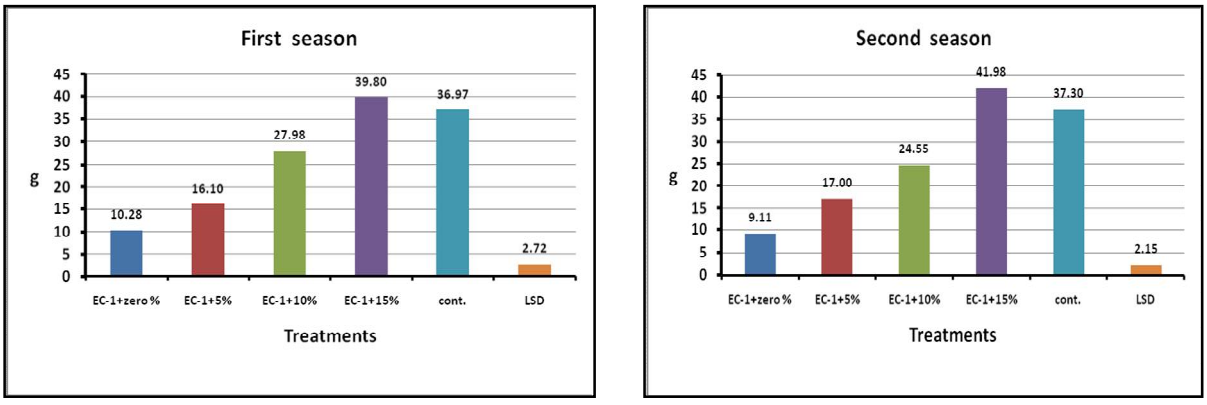


**Fig. 2:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on leaves dry weight (g/plant) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Root fresh weight:**

Data collected from the first season showed that the highest root fresh weight values were recorded by plants grown in EC-1+15% followed by control. Moreover, EC-1+10% recorded a higher root fresh weight values than EC-1+5%. On the other hands, the lowest values were obtained by plants grown in EC-1+zero%. Furthermore, data indicated that all differences among treatments were significant. Data showed the same trend in the second season. Fig (3)

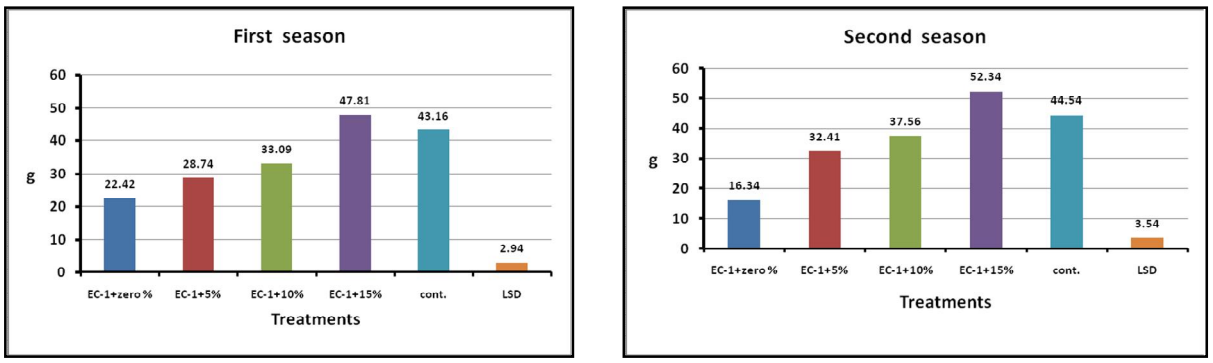


**Fig. 3:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on root fresh weight (g/plant) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Root dry weight:**

Data collected from the first season indicated that EC-1+15% recorded the highest root dry weight values followed by control, then EC-1+10% and EC-1+5% respectively. However, plants grown in EC-1+zero% recorded the lowest root dry weight values. Data also indicated that differences among treatments were significant except the difference between EC-1+15% and control. Similar trends were observed in the second season except that differences among all treatments were significant. Fig (4)

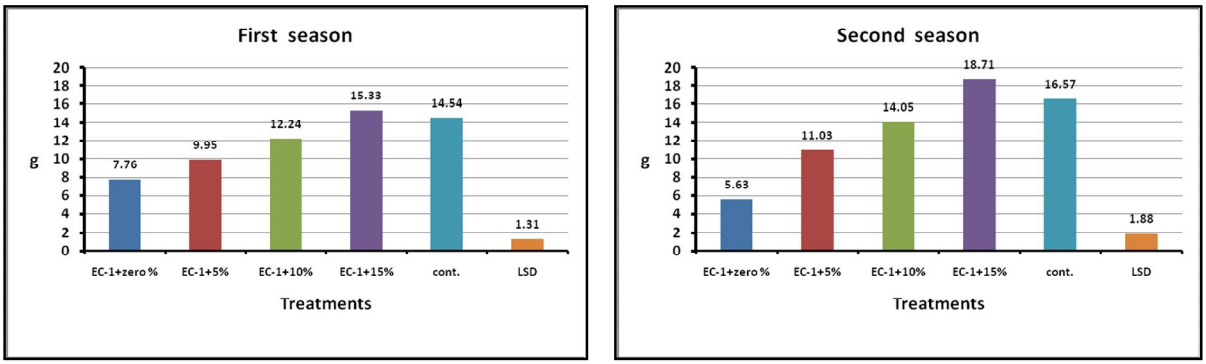


**Fig. 4:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on root dry weight (g/plant) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Dry matter percentage per plant:**

Data collected from both seasons indicated that there were no significant differences among treatments regarding dry matter percentage per plant. Fig (5)

**Yield:**

Data in Fig (6) presents the effect of compost addition in different percentages to growing medium on yield per $m^2$ of red leaf lettuce. Data collected from both seasons illustrated that the highest yield values per $m^2$ were recorded in EC-1+15% followed by control, then EC-1+10% and EC-1+ 5% respectively.

Otherwise, EC-1+zero% recorded the lowest yield values. Data collected from the first season indicated that differences among treatments were significant except the difference between EC-1+15% and control was not significant. Nevertheless, all differences among treatments were significant in the second season.

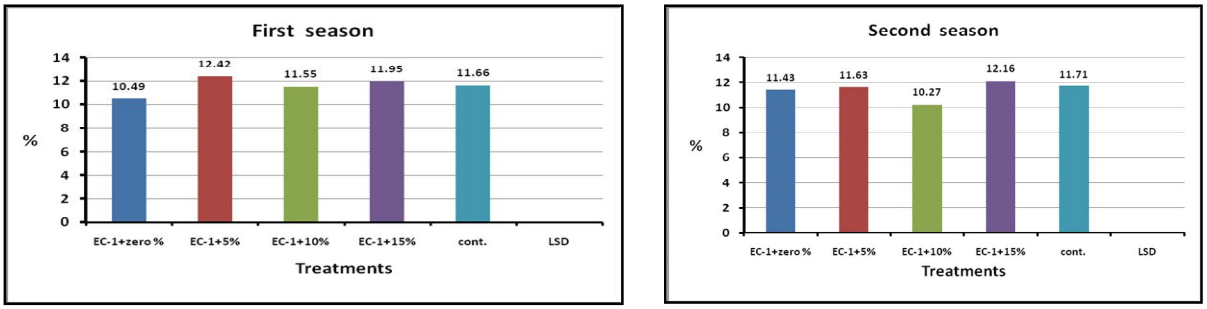


**Fig. 5:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on dry matter percentage (%) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

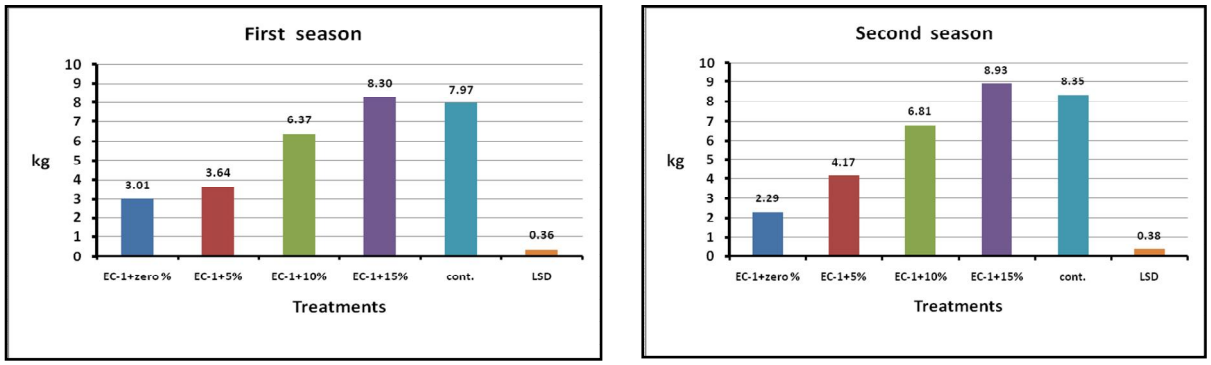


**Fig. 6:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on yield (kg/m$^2$) of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Nitrogen percentage in leaves:**

Data collected from both seasons illustrated that plants grown in EC-1+15% recorded the highest nitrogen % in leaves followed by control. The difference between EC-1+15% and control was not significant in the first season but was significant in the second season. Furthermore, in both seasons EC-1+10% recorded a higher nitrogen % than EC-1+ 5% and EC-1+zero%, and the differences among them were significant. Fig (7)

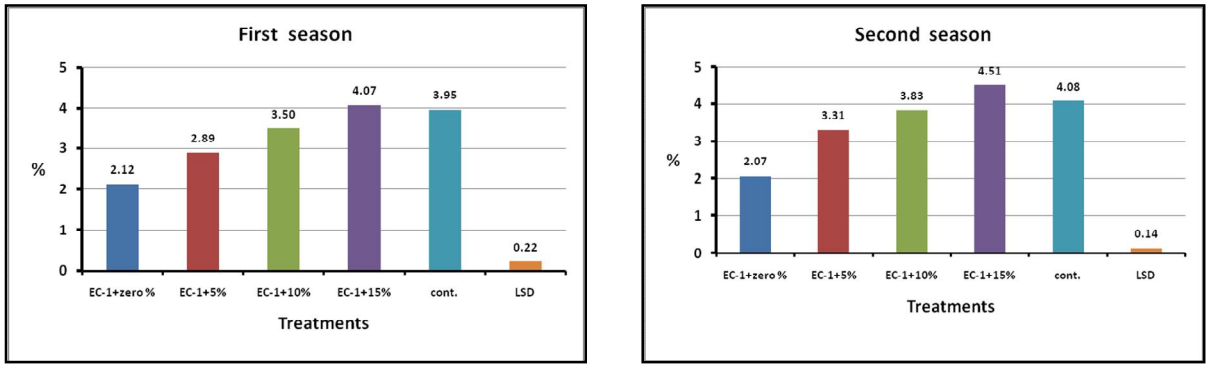


**Fig. 7:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on nitrogen % in leaves of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Phosphorus percentage in leaves:**

Data in Fig (8) presents the effect of compost addition in different percentages to growing medium on phosphorus % in leaves. Data collected from the first season illustrated that the highest phosphorus % was recorded in EC-1+15% then control, EC-1+10%, EC-1+ 5% and EC-1+zero% respectively. Moreover, data showed that all differences among treatments were significant. Data indicated similar trend in the second season except that the difference between EC-1+15% and control was not significant.

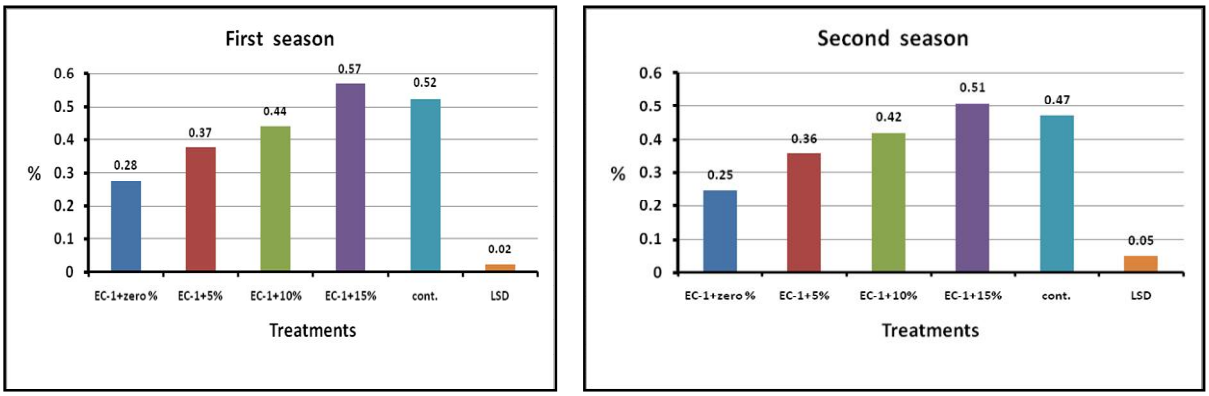


**Fig. 8:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on phosphorus % in leaves of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

**Potassium percentage in leaves:**

Data collected from the first season indicated that control treatment recorded the highest potassium % followed by EC-1+15%, then EC-1+10% followed by EC-1+ 5%, while EC-1+zero% recorded the lowest potassium %. Data also indicated that differences among treatments were significant. Similar trends were observed in the second season except that EC-1+15% recorded a higher potassium % than control but the difference between both of them was not significant. Fig (9)

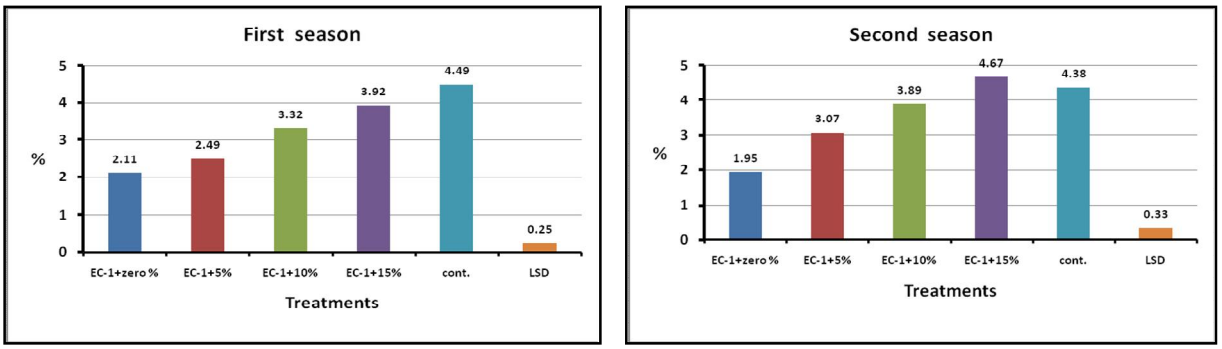


**Fig. 9:** Effect of compost addition in different percentages to growing medium to reduce the use of inorganic nutrient solution on potassium % in leaves of red leaf lettuce plants grown on rooftops during seasons of 2012 and 2013.

## Discussion

Results illustrated that the use of compost as a part of the growing medium reduce the need of inorganic nutrient solution; the combination between compost addition by 15% to growing medium and irrigation with inorganic nutrient solution adjusted at 1m.mhos$^2$ (EC-1+15%) recorded the highest values for yield per m$^2$ and this may be a result to hypothesis assumed that compost addition as a part of the growing media enhanced the root growth environment, this permitted plants to build a good root system which supported plants to form better leaves translated to higher yield. This idea could be supported by results indicated that plants grown in EC-1+15% recorded bigger root system (root fresh and dry weights)

than control treatment that irrigated with inorganic nutrient solution adjusted at 2m.mhos$^2$ without the use of compost as a part of the growing medium, also EC-1+15% recorded higher values than control regarding leaves fresh and dry weights, and higher percentages of nitrogen and phosphorus in leaves. Zibilske, (1987) reported that beside the role of compost in supplying plants with nutrients, compost has been shown to increase the level of soil organic matter, enhance root development, improve the germination rate of seeds, and increases the water holding capacity of soil. Applied organic materials promote biological activity in the soil, as well as a favorable nutrients exchange capacity, water balance and increases organic matter. In addition, Stoffella and Graetz, (1996) found that tomato transplanted in pots with compost or compost mixtures had higher shoot weights, thicker stems, and larger shoot to root ratios than plants grown in un-amended field soil. Moreover, Mastouri *et al*., (2005) studied the use of two types of compost (Tea Waste Compost "TWC" and Tree Bark Compost "TBC") for container production of lettuce. Nine growing media mixtures including 3TWC+1Soil (on a volumetric basis), 1TWC+1Soil, 1TWC+3Soil, 3TBC+1Soil, 1TBC+1Soil, 1TBC+3Soil, 1TWC+1TBC, 1TWC+1TBC+1Soil, and Soil (control) have been used in this experiment. No supplementary fertilization was applied until harvest. Results revealed that either types of compost increased yield over control (soil). However, growth, dry matter accumulation, and head weight was lower in TBC amended media than that of TWC amended media. Furthermore, Abdelrahman *et al.,* (2012) have evaluated the use of two types of compost as components of growing media for organic melon seedlings production. Differentiated on the basis of the volume percentage of both compost types and compared to the control (a mixture of peat, coconut fiber and perlite without compost). Results indicated that compost addition has affected the chemical and physical characteristics of the media. In terms of performance, seedlings growth in treatments containing 30 and 50% of composts was significantly higher than the control.

## Conclusion

From the above mentioned results, it could be concluded that the combination between compost addition by 15% to growing medium and irrigation with inorganic nutrient solution adjusted at 1m.mhos$^2$ could be recorded as the best combination between compost as a part of the growing media and concentration of the inorganic nutrient solution for producing red leaf lettuce in comparison with control that irrigated with inorganic nutrient solution adjusted at 2m.mhos$^2$ without the use of compost as a part of the growing medium.

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