The effects of irrigation with saline water on some morphological traits in Basil (*Ocimum basilicum*)

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Abstract

One of the methods for the management of saltwater and brackish is the use of different irrigation regimes with saltwater and freshwater. Basil (Ocimum basilicum) is the most important economic species among the species of the genus of Ocimum and to be planted around the world. To study the effect of different irrigation regimes with saltwater and freshwater on morphological traits of medicinal plant of Basil, a test was conducted on a sample farm in Islamic Azad University of shahre ghods (with the longitude '21 ˙40 Western and latitude '38 ˙27 Northern with an altitude of 1417 meters above sea level) at 2012-2013 growing season. The experiment was conducted in a randomized complete block design with six treatments and three replications (a total of 18 lysimeters). The overall results of this study showed that salt stress has a significant effect on Stem height without floral twig, stem diameter, shoot fresh weight, shoot dry weight, leaf length, and leaf width in the basil herb. Salt stress affects the whole plant physiology and decreased in comparison With normal irrigation. Also the results of measured correlation traits that were affected by the irrigation treatments in this experiment revealed that studied traits in this study have significant correlation. Further research is also required in order to obtain the best method of irrigation in different conditions and different climates for basil.

Keywords: basil, Lysimeter, correlation, agronomic traits

Introduction

Salinity is one major environmental determinant of plant growth and productivity. Salinization is rapidly increasing on a global scale and currently effect more than 10% of arable land, which results in a decline of the average yields of major crops greater than 50 % (Wang *et al*., 2009).Therefore understanding the mechanisms of plant tolerance to high salinity stress is a crucial environmental research topic .The effects of salinity were determined at seedling stage of wheat range from reduction in germination percentage, fresh and dry weight of shoots and roots to the uptake of various nutrient ions (Afzal *et al*., 2005) Salinity appears to affect two plant processes: water relations and ionic relations. During initial exposure to salinity, plants experience water stress, which in turn reduces leaf expansion and therefore photosynthesis and all other processes which depend upon photosynthesis. During long-tern exposure to salinity, plants experience ionic stress, which can lead to premature senescence of adult leaves, and thus a reduction in the photosynthetic area available to support continued growth (Sultana *et al*., 1999) salt also affects photosynthetic components such as chlorophylls and carotenoids.Changes in these parameters depend on the severity and duration of stress (Mirsa *et al*., 1997) and on plant species (Dubey *et al*., 1994). High concentrations of salts also disrupt homeostasis in water potential and ion distribution in plants. Altered water status most likely brings a bout initial growth reduction (Dash and Panda., 2001) Specific effects of salts stress on plant metabolism, especially on leaf senescence, have been related to the accumulation of toxic ion (Na+ and K+ depletion) (Al-Karaka *et al*., 2000) (Demiral *et al*., 2005). At the cellular level osmotic stress causes alterations in membrane Lipid composition and properties. It has been postulated that at least part of the induced leakiness of membrane is caused by lipid peroxidation resulting from uncontrolled ROS increase (Rodriques-Rosales *et al*., 1999) Measurement of thiobarbituricacid reacting substances (TBARs) concentration such as malondialdehyde (MDA) is routinely used as an index of lipid peroxidation under stress conditions. (Gapinska *et al*., 2008). Rapid accumulation of free proline is also a typical response to salt stress and when plants are exposed to drought or a high salt content in the soil, many plants accumulate high amounts of proline, in some cases several times the sum of all the other amino acids (Mansour *et al*., 2000). The role of proline in protection of cell membranes against salt injury has been discussed (Mansour *et al*., 1998).

The purpose of this study was to identify the effects of different irrigation regimes with salt water and fresh water on agronomic traits of basil.

Materials and methods

To study the effect of different irrigation regimes with saltwater and freshwater on morphological traits of medicinal plant of Basil, a test was conducted on a sample farm in Islamic Azad University of shahre ghods (with the longitude '21 ˙40 Western and latitude '38 ˙27 Northern with an altitude of 1417 meters above sea level) at 2012-2013 growing season.

The experiment was conducted in a randomized complete block design with six treatments and three replications. Experimental treatments were:

I) 100% fresh water as the control ($EC = 0.6\ ^{ds}/_{m}$)

1I) 100% saline water ($EC = 6\ ^{ds}/_{m}$)

2I) 50% saline water and 50% fresh water. In this treatments, Irrigation performed once with salt water and once with fresh water in the form of decussate

3I) Mixed treatment (75% fresh water and 25% saline water). In this treatment a mixture of fresh and saline water were applied.

4I) Mixed treatment (75% saline water and 25% fresh water) this treatment is similar to the prior mixture treatment.

5I) intermittent treatment: in this treatment, irrigation was performed once with saline water and again with fresh water.

Medicinal herb of basil was irrigated with fresh water until stem elongation stage and of the stem elongation stage until the harvest was irrigated with six different treatments.

To run the experiment, we used 18 cylindrical and plastic lysimeters made of the solid polyethylene which was 60 cm in diameter and 100 cm in height. To remove excess water of the lysimeters, a netted tube at the bottom of the lysimeter was considered. Then for the moisture in the soil did not affect the testing process, lysimeters were placed 40 cm above the metallic bases. After mounting lysimeters in the ground, at the bottom of each lysimeter was dumped 15 centimeters of sand so that sand conduct existing water in different levels of soil within the lysimeters to the leachate, then inside them was filled with field soil (the soil taken from a depth of 0-45 cm of arable ground) up to a height 85 cm and Irrigation was done until the soil achieved to the FC situation and initial moisture for planting the seed be provided. To prepare the water with salinity 6 dS m, we used from the well water and its water was mixed with sodium chloride. After dissolving, it was measured with a digital ECmeter to obtain the desired amount of salt, then irrigation regimes were prepared and added to the lysimeters. Traits measured in this experiment consisted of measuring Stem height without floral twig, Stem diameter, Shoot fresh weight, Shoot dry weight, Leaf length and leaf width. To determine the dry weight of shoots, different tissues were incubated for 72 h in an oven at 70 ° C and then were measured. SAS software version 9.1 was used for statistical analysis plan (analysis of variance, mean and correlation analysis) and the mean comparison charts were drawn by Excel 2013.

Results and discussion

Effects of irrigation levels on stem height without floral twig

Analysis of variance showed that (Table 1) between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of stem height without floral twig. The maximum stem height without floral twig of the control irrigation treatments calculated at the rate of 43/66 centimeters and the lowest stem height without floral twig of 1I irrigation calculated at the rate of 32/33 centimeters (Table 2). There were no significant differences among 2I and 5I irrigation treatments, but other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical. As shown in Table 2, lowest stem height without floral twig were obtained by irrigation with saline water. Because salt stress limits the growth of plants, like many other abiotic stresses. Growth retardation is an adaptation got by plants to survive under the stress (Zhu, 2001). The maximum height of stem height without floral twig obtained in irrigation treatment with fresh water (Table 2), this result is not unexpected for a glucofital plant like basil, because glucofits be less compatible with high levels of salt and grow well only in non-saline conditions (Levitt, 1980; Volkmar et al., 1998).

Effects of irrigation levels on stem diameter

The results showed that (Table 1) between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of stem diameter. The maximum stem diameter of the control irrigation treatments calculated at the rate of 1/16 centimeters and the lowest stem diameter of 1I irrigation calculated at the rate of 0/76 centimeters (Table 2). There were no significant differences among 2I and 5I irrigation treatments, but other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical. As was observed, lowest stem diameter were obtained by irrigation with saline water, because in lowering osmotic potential, free energy of water reduced and plant to obtain a certain amount of water must spend more vital energy. So the part of the energy that plants need it for growth is spent obtaining water. Thus, growth of the plants (plant height, stem diameter, etc.) and the amount of product decreases. This effect is called the “osmotic effect”. In this case, there is a need to regulation of osmotic by cells to avoid drought (physiological drought caused by salt stress), in other words, the accumulation of solutes in response to salinity stress is a kind of reaction that occurs in the face of water stress.

Effects of irrigation levels on shoot fresh weight

Analysis of variance showed that (Table 1) between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of shoot fresh weight. The maximum shoot fresh weight of the control irrigation treatments calculated at the rate of 27/33 grams and the lowest shoot fresh weight of 1I irrigation calculated at the rate of 9/73 grams (Table 2). There were no significant differences among 2I and 5I irrigation treatment, but other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical (Table 2). Reduction in growth is the most important plant response to salinity. Soil Salinity affects plant's physiological activities in several ways. When the concentration of soluble salts in the soil is high, this appear the signs of damages to plant caused by salinity. Reduction in plant growth because of salt stress could be due to changes in the allocation of materials such photoassimilate (photosynthesis products) to the roots, decrease growth on aerial parts especially the growth of leaves, partial or total closure of stomata, due to the direct effect of salt on the photosynthetic system and the effect on ionic balance.

Effects of irrigation levels on shoot dry weight

In this experiment, between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of shoot dry weight (table 1). The maximum shoot dry weight of the control irrigation treatments calculated at the rate of 3/02 grams and the lowest shoot dry weight of 1I irrigation calculated at the rate of 1/36 grams (Table 2). There were no significant differences among 2I, 3I and 5I irrigation treatments, among 2I, 4I and 5I irrigation treatments and among the control and 4I irrigation treatments. But other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical. The results also showed that the lowest weight, shoot dry basil obtained from irrigation treatment with saline water (Table 2). We can say that the integrity of cell membranes, various enzymes, nutrient uptake and function of photosynthetic apparatus are all susceptible to the effects of salt stress, one of the most important causes of these damages may be generate a variety of reactive (active) oxygen by salt stress. Oxidative stress is a secondary aspect of salinity on plant and produces reactive oxygen types due to the tension including superoxide radicals ($O2^-$), hydrogen peroxide (H_2O_2) and hydroxyl radicals (OH). Reactive forms of oxygen are product of the changed metabolism of chloroplasts and mitochondria during the stress. This type of oxygen causes oxidative damage to cellular components such as lipids, membrane proteins and nucleic acids. Reduction in plant growth because of salt stress could be due to changes in the allocation of materials such photoassimilate (photosynthesis products) to the roots, decrease growth on aerial parts especially the growth of leaves, partial or total closure of stomata, due to the direct effect of salt on the photosynthetic system and the effect on ionic balance. (Haidari, 1380). Glucofit be less compatible with high levels of salt and will grow well only under non-saline conditions (Levitt, 1980; Volkmar et al., 1998).

Effects of irrigation levels on leaf length

Analysis of variance showed that (Table 1) between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of leaf length. The maximum leaf length of the control irrigation treatments calculated at the rate of 3/82 centimeters and the lowest leaf length of 1I irrigation calculated at the rate of 2/17 centimeters (Table 2). There were no significant differences among 2I and 5I irrigation treatments and among 2I and 4I irrigation treatments. But other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical. As was observed, lowest leaf length were obtained by irrigation with saline water (Table 2), the results correspond with the results of research done in the past. The first reaction of glucofit plants against salinity is decrease in the growth of leaf (Mans and Termat, 1986). This reduction may result from a direct effect of salt on cell division or thereby reducing duration of cell development. It also seems that in glucofit, the inability of leaves to accommodate and enjoy the transported salt from roots at a pace commensurate with receive it. It low down the growth of leaves and ultimately leads to the death of leaves (Volkmar et al., 1998). Salinity affects mainly two herbal processes: water relations and ionic relations. At the beginning of exposure to salinity, plants experience water stress which in turn reduces the growth and development of the leaf. Long-term exposure to salinity, plants experience stress ionic which can lead to premature aging Decrease in the photosynthetic surface (Seltana et al., 1999).

Effects of irrigation levels on leaf width

Analysis of variance showed that (Table 1) between the different irrigation treatments for basil, there is very significant statistical difference at 1% in terms of amount of leaf width. The maximum leaf length of the control irrigation treatments calculated at the rate of 6/16 centimeters and the lowest leaf length of 1I irrigation calculated at the rate of 2/09 centimeters (Table 2). There were no significant differences among 2I and 5I irrigation treatments and among 2I and 4I irrigation treatments. But other treatments showed a significant difference with the control treatment and compared to the control treatment it seems logical. This reduction may result from a direct effect of salt on cell division or thereby reducing duration of cell development. It also seems that in glucofit, the inability of leaves to accommodate and enjoy the transported salt from roots at a pace commensurate with receive it. It low down the growth of leaves and ultimately leads to the death of leaves (Volkmar et al., 1998). The reduction in leaf area declines the light absorption and the total capacity photosynthetic of plant or canopy cover which leads to a decrease in supply of photosynthetic preparations for growth. In addition, the rapid aging of leaves under salt stress leads to a reduction in leaf area. Growth of new leaves is supported by the transfer of carbon from mature leaves. When the ability of older leaves to support new leaves are reduced (due to necrosis of leaves caused by too much salt) production and growth of new leaves is difficult (Volkmar et al, 1998). There are several reports about the reduction of leaf area index (LAI) due to salinity in various plants (Heydari, 1380). The investigation showed that LAI decreased due to reduction in leaf area, the phenomenon of necrosis and defoliation caused by salinity (Deraz Kiwix, 1994).

Correlation of Characteristics results

Correlation of Characteristics of measured results are influenced by irrigation treatments in this experiment showed that the traits have significant correlations with 1% and 5% levels (Table 3). The results of these correlations is listed below.

1. There is a significant positive correlation between the percentage of total nitrogen and protein content (0/925), which represents that whatever percentage of total nitrogen is higher due to assimilate translocation; percent of performance increase, protein and carbohydrate content decreases.

2. There is a significant negative correlation between the Percent of sodium with chlorophyll a (0/978) and sodium have a significant negative correlations with chlorophyll b (0/867) and sodium have a significant negative correlation with total chlorophyll (0/957) which represent that the more the sodium, the lower the photosynthetic, the result is less chlorophyll and reduces the performance.

3. There is a significant positive correlation between percent of sodium and percent of proline (0/814) and a positive correlation between peroxidase and percent of proline (0/981) which represent that the more the sodium, the more synthesized peroxidase and more Proline accumulates in plant under Salinity Stress.

4. There are a significant positive correlation between the heights of the stem without floral twigs with stem diameter (0/980) and a significant positive correlation between stem heights with leaf length (0/875) and a significant positive correlation between stem heights with leaf width (0/981) and a significant positive correlation between stem heights and shoot fresh weight (0/919) and a significant positive correlation between Stem height and shoot dry weight (0/940) which represent that the more the stem height, the more the light that enter the canopy of plant; This increases the rate of growth of the canopy of plant and as a result it produced more photosynthetic materials and ultimately increase the biological function of plant.

Overall Conclusion

Freshwater resources have declined in many parts of the world and reserves of fresh water are limited, that part of it are provided by natural resources. So little rain has caused severe fluctuations in the water level so that with the arrival of the hot season, especially in summer, surface water is often decreases. In these circumstances, farmers to supply up water needed to plant various plants use groundwater as well as surface water. Iran is a vast country with an average rainfall of 25 mm per year and like other countries in the region that are located in dry land suffers from water shortages and predicted that over the next half century, it is included the 66 countries that water stress reduced the development of economic activities. Freshwater reserves declined due to the increasing use of urban-industrial societies and increasing per capita consumption. Thus, with the increase in population and agricultural expansion, human concentrated on further use of salty water. Unfortunately, optimum use of water still has not found its place as a culture. For this reason, achieving a relative balance of supply and demand of water is an essential principle, it is possible only by a comprehensive system of water management. Salinity in Iran and arid regions of the world is considered a major problem and limiting factor for growth, quality and yield of crop plants. Salinity factor had a significant effect on plant height without floral twigs, stem diameter, leaf length, leaf width, Shoot fresh weight and shoot dry weight of basil. Salinity affects the whole plant physiology and decreased compared with normal irrigation. Further research is also required in order to obtain the best method of irrigation in different conditions and different climates for basil.

Resources

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Table 1. Analysis of variance (mean square) of morphological traits in basil under different irrigation treatments

Sour ces of variation	D egrees of freedom	St em height without floral twig (cm)	S tem diameter (cm)	Sho ot fresh weight (gr)	S hoot dry weight (gr)	L eaf length (cm)	L eaf width (cm)
Repl ication	2	44 /720	0 /065	522 3/8	2 1/867	0 /566	1 0/87
Irrig ation treatments	5	۲۰ ۸/078**	0 /057**	/012 100/2**	1 /144**	0 /987**	3 /889**
The experimental mistake	1 0	۱/ 073	0 /001	0/79 4	0 /067	0 /003	0 0/638
Coef ficient of variation (CV%)		3/ 087	3 /21	4/46 9	1 0/828	1 /708	2 5/79

**: Significant at 1% probability level

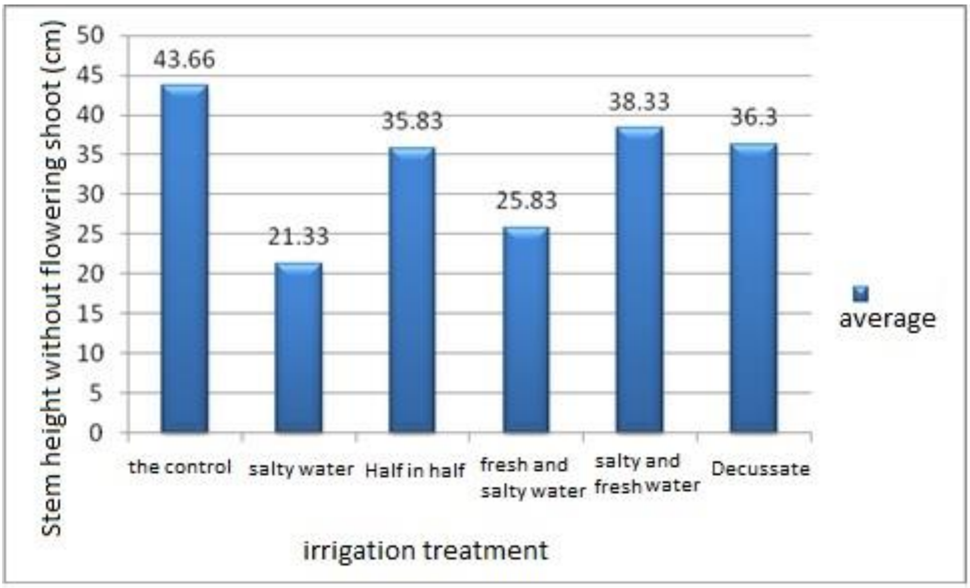

Fig1. The height of the stem without floral twigs

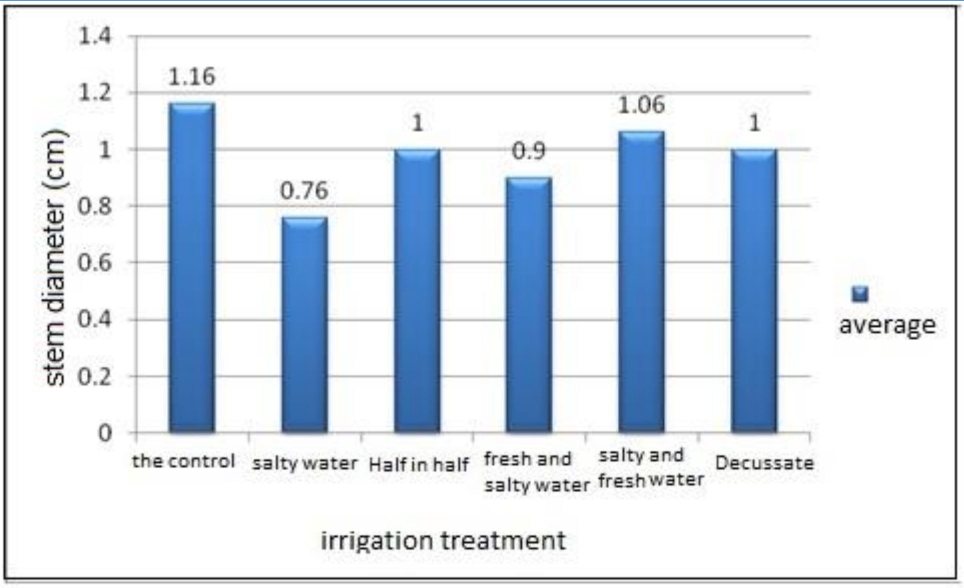

Fig2. Effect of irrigation levels on stem diameter

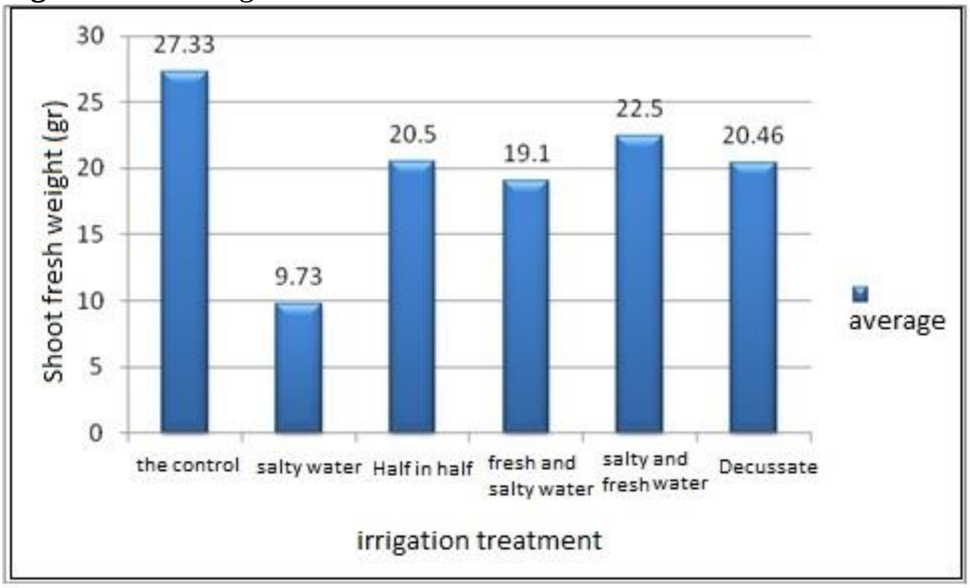

Fig3. Effect of irrigation levels on shoot fresh weight

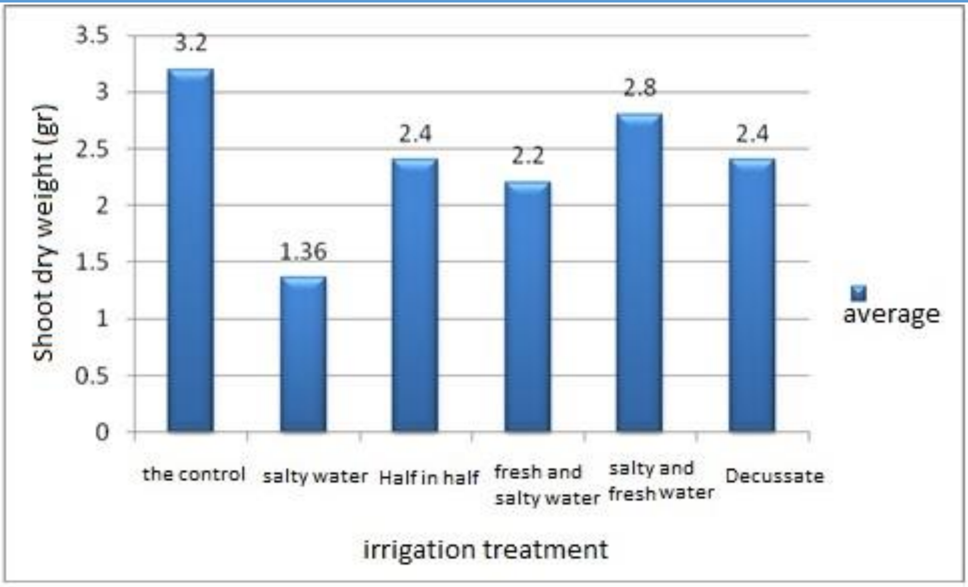

Fig4. Effect of irrigation levels on shoot dry weight

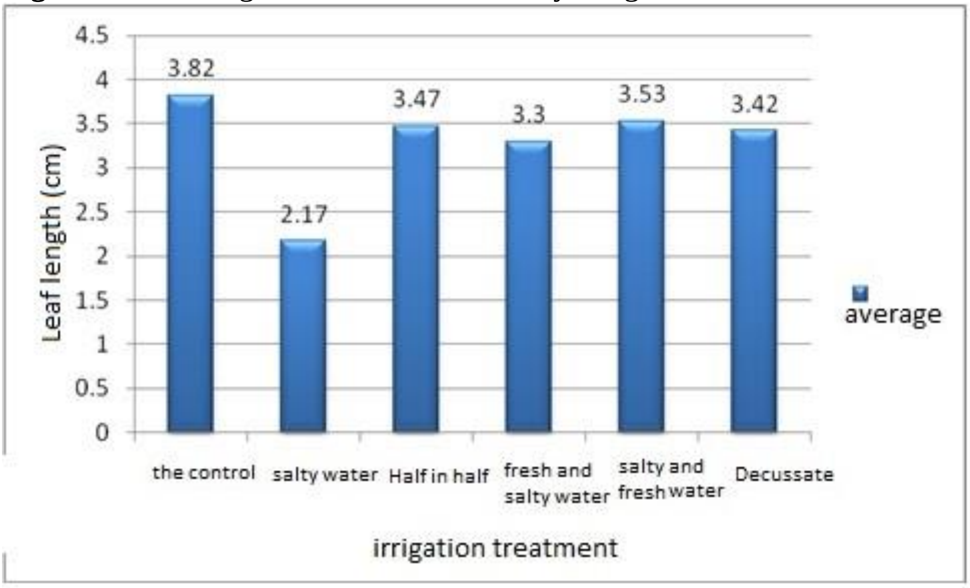

Fig5. Effect of irrigation levels on leaf length

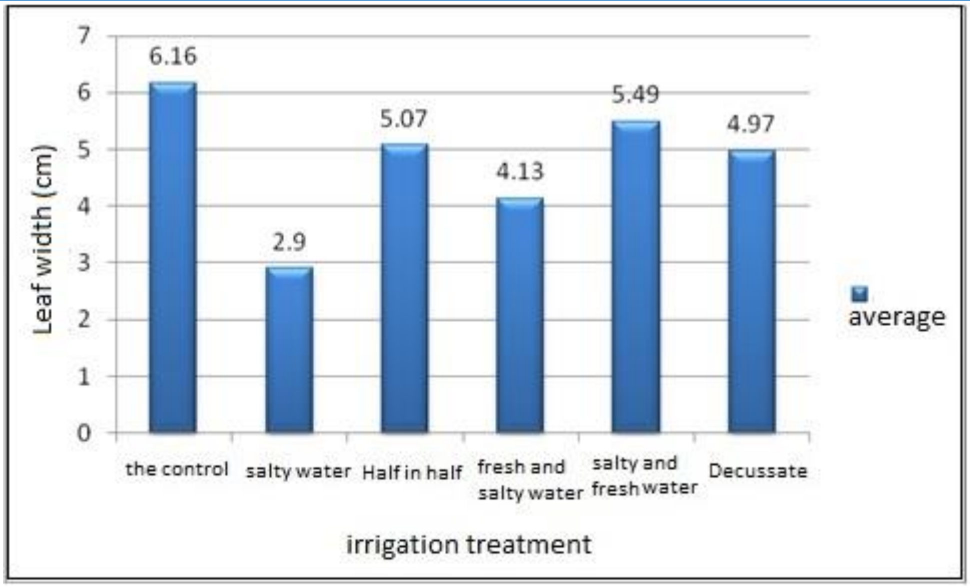

Fig6. Effect of irrigation levels on leaf width

Table 2. morphological traits in basil under different irrigation treatments

	Stem height without floral twig (cm)	Stem diameter (cm)	Shoot fresh weight (gr)	Shoot dry weight (gr)	Leaf length (cm)	Ieaf width (cm)
Stem height without floral twig (cm)	1					
Stem height without floral twig (cm)	0.980**	1				
Stem height without floral twig (cm)	0.919**	0.972**	1			
Stem height without floral twig (cm)	0.940**	0.988**	0.990**	1		
Stem height without floral twig (cm)	0.875*	0.922**	0.975**	0.947**	2	
Stem height without floral twig (cm)	0.981**	0.996**	0.974**	0.984**	0.943**	3

** And * respectively significant at 1% and 5%