Deanship of Graduate Studies

Al-Quds University

The Environmental Impact of Using Magnetized Water in irrigation of Herbs Crop in The Lower Jordan Valley/ West Bank-Palestine

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M.Sc. Thesis

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Thesis Approval

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Dedication

This work is dedicated to my beloved family for their support.

A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity were as a ring in my ears. My sisters and brothers have never left my side and are very special. I also dedicate this thesis to my best friends who have supported me throughout the process.

This work was done specially to assist my lovely homeland **"Palestine"**...

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

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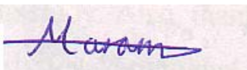
Signed: 

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Abstract

Agriculture is considered to be one of the most important sectors of the national income and food security in Palestine. It's located mainly in Lower Jordan Valley, Tubas, Jenin, Qalqleih, and Tulkarem. There is a serious need to develop this sector by improving the ways of irrigation and the quality of water used. Lower Jordan Valley depends on ground water for irrigation which contains high levels of salts. The increase in water salinity has negative impact on soil structure, decrease permeability and soil aeration, and also reduces crops diversity and crops yield.

This problem was solved by using Magnetic Water Technology. The technology of using magnetized water in the irrigation of different crops is widely used nowadays. This technology has a great impact on decreasing soil salinity, resulting in an increase on water productivity and fresh yield of plants.

In the current pilot project, the work was directed toward using magnetized water in the irrigation of medical herbs (Oregano and Terragon). The global increase on the demand of medical herbs makes the Lower Jordan Valley area an attractive field for growing medical herbs during cold winter months (2012/2013). The studied herbs were planted in greenhouses. For each crop (Oregano and Tarragon) two greenhouses were planted, one was irrigated by magnetized water and the other by controlled water (untreated water). During two months, the height, major and minor branches, crops yield, water productivity and chlorophyll and water contents were measured, in order to be studied. The soil electrical conductivity was measured for both soils (treated and controlled) using EC meter. After recording and analyzing data, it was found that the magnetic treatment of water has a positive effect on increasing the fresh yield, water productivity, water and chlorophyll contents, and fresh root biomass for both Oregano and Tarragon. The influence of magnetized water on Tarragon was less than that on Oregano which indicate that Tarragon is more resistant to salinity than Oregano.

There was a decrease in the number of blocked drippers for treated water compared to controlled water for both medical herbs. Based on these results, the number of damaged seedlings was higher in the greenhouse irrigated by controlled water for Oregano

but unlike expected the number of damaged seedlings was lower in the greenhouse irrigated by controlled water for Tarragon. In addition it was found that the salinity of soil was decreased when using magnetized water.

الأثر البيئي لاستعمال المياه المعالجة مغناطيسياً في ريّ محاصيل الأعشاب في منطقة غور الأردن

إعداد: مرام هشام خميس بصيلة.

المشرف: د. عامر مرعي.

الملخص

يعتبر القطاع الزراعي من اهم القطاعات التي تساهم في زيادة الدخل القومي والأمن الغذائي في فلسطين، حيث تتركز في بشكل اساسي في منطقة غور الأردن وطوباس وجنين وقلقيلية وطولكرم، ونظرا لأهمية هذا القطاع هناك حاجة ماسة للعمل على تطوير طرق الري وتحسين نوعية المياه المستخدمه بالري، حيث ان الزراعة في غور الأردن تعتمد بشكل أساسي على الري من المياه الجوفية والتي تعاني من مشكلة الملوحة الزائدة وهذه الملوحة لها أثار سلبية على كل من التربة والمحاصيل فتقلل نفاذية التربة وتهويتها كما تؤدي الى تقليل تنوع النباتات وكمية المحاصل.

ولحل هذه المشكلة تم استخدام تكنولوجيا معالجة المياه مغناطيسيا، والتي انتشرت مؤخرا في عدة بلدان لري انواع مختلفة من المحاصيل، حيث ان لهذه التكنولوجيا اثار ايجابية على ملوحة التربة وزيادة المحاصيل وانتاجية المياه.

لوحظ زيادة الإعتماد العالمي على استخدام الأعشاب الطبية وكانت منطقة الغور منطقة استراتيجية ومناسبة لزراعة هذه الأعشاب، وقد تم في هذا المشروع دراسة تأثير استخدام المياه المعالجة مغناطيسيأ على نوعين من الأعشاب الطبية وهم الزعتر والترغون وقد نفذ هذا المشروع في شتاء (٢٠١٢-٢٠١٣). وهذه الدراسة تمت في البيوت البلاستيكية حيث تم زراعة بيتين بالزعتر واخرين بالترغون وري احدى البيتين بالمياه المعالجة والآخر بالمياه العادية(غير معالجة).وخلال فترة الدراسة قمنا بمراقبة نمو النباتات وعدد الفروع للنباتات كما قمنا بعمل فحوصات مخبرية مثل نسبة المياه والكلوروفيل لكلا العشبتين ومقارنة نتائج النباتات المروية بالمياه المعاجة والمياه العادية، كما قمنا بدراسة الانتاجية لكلا المحصولين.

ومن خلال الدراسة لاحظنا زيادة في الانتاج وانتاجية المياه لصالح الاعشاب المروية بالمياه المعالجة، كما سجلنا زياده في نسبة المياه التي تحتويها الاعشاب وكذالك زيادة في كمية الكلوروفيل المنتجة، وكان هناك زيادة في كتلة الجذور لكلا العشبتين.

وكان من الملاحظ ان تاثير المياه المعالجة اكثر وضوحا لعشبة الزعتر منها لعشبة الترغون، مما دفعنا الى الاستنتاج ان عشبة الترجون اكثر مقاومة للملوحة.

وعند دراسة عدد النقاطات المغلقة نتيجة ملوحة المياه وجد ان عددها اقل عند استخدام المياه المعالجة. كما لوحظ ان عدد النبتات المفقودة في البيت المروي بالمياه العادية اكثر من عددها في البيت المروي بالمياه الغير معالجة بالنسبة للزعتر وعلى العكس كانت بالنسبة للترغون.

وكذلك كان للمياه المعالجة تاثيرا ايجابيا على ملوحة التربة، حيث ان ملوحة التربة كانت اقل للتربة المروية باستخدامها.

List of Abbreviation:

Abbreviation	Full Name
kg/ m^3	Kilogram per cubic meter
MCM	Million cubic meter
LJV	Lower Jordan valley
mm/a	Millimeter annually
mS/cm	Milli-siemens per centimeter
MoA	Ministry of Agriculture
RO	Reverse Osmosis
FAO	Food and Agriculture Organization of the United Nations
C	Control
T	Treated
MWT	Magnetic water treatment
TDS	Total Dissolved Solids
EC	Electrical Conductivity
m^3	Cubic meter
m^3/h	Cubic meter per hour
NPK	Nitrogen phosphorus potassium
m^3/dun	Cubic meter per dunum
gm	Gram
ml	Milliliter
AQU	Al-Quds University
mg	Milligram
cm	Centimeter
kg	Kilogram
kg/dun	Kilogram per dunum
Na	Sodium
Mg	Magnesium
Ca	Calcium
Cl	Chloride
m	Meter
m^2	Meter square
km^2	Kilometer square
nm	Nanometer
kw/m^3	Kilowatt per cubic meter
µS/cm	Micro Siemens per centimeter
MW	Magnetized Water

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Chapter One:

Introduction

1.1 Introduction

In the West Bank local water sources (spring water and borehole water) cover about 65% of Palestinian water needs, which is about 150MCM\a. (PWA, 2010). Lower Jordan Valley (LJV), Tubas, Jenin, Qalqleih, and Tulkarem are the main areas where agricultural activities are concentrated. (MoA, 2011). This sector consumes about 65% of the local water sources. At least 70% of the LJV inhabitants depend mainly on agriculture, which is considered as the second source of the national gross income. Because of that the Ministry of Agriculture and other organization support this sector.

In LJV the ground water from Plio-Plistocene Shallow aquifer system is considered as the major water source for agriculture. In LJV most farmers adopted many irrigation technologies, such as drip irrigation; they use the boreholes groundwater from different resources for agriculture activities without any treatment before use even though this water is classified to be saline water.

LJV spring drain water from a karstic Mountain carbonate aquifer system with high fluctuation discharge rate (Guttman, 2007), and most of agricultural activities depend on covering its water needs on groundwater from boreholes. The depth of these boreholes ranges between 100 and 150 m below the surface and the salinity ranges between 2.5 and 5.5 mS/cm (Manasra, et al. 2013). In general the groundwater salinity increases during the last few decades three folders and this phenomena relates to the limitation of natural groundwater replenishment and over-pumping from the shallow Plio- Pleistocene aquifer system (Manasra, et al. 2013).

Herbs like Oregano, Thymine, Tarragon, Salvia and other medical plants are well known herbs by the population in the Eastern part of the Mediterranean Basin, and are historically still used in traditional medicine for many centuries (Yeşilada, et al. 1995, Saad, et al. 2005, Azaizeh, et al. 2008). Medical herbs are also used in cosmetic, herbal tea, species, liqueurs, insecticides, fungicides and pharmaceutical industry, and its essential oils can inhabit the growth of moulds and food borne bacteria (Paster, et al. 1990). (Alçiçek, et al. 2004, Symeon, et al. 2009), reported also an improvement of broiler growing by adding wide medical herbs to the dietary.

In Europe, the cultivated area with medical herbs was about 70000 hectares. France, Hungary and Spain are the main producers. On the other hand, in 1996 the European countries imported about 440 000 ton of medical herbs which is about ¼ of the global production at a value of 1.3 billion US$(Farnsworth and Soejarto 1991, Lange 1998)

The natural growing locations of these herbs in the West Bank are along the mountain ridges where semi humid to semi-arid climatic zones dominate. In these zones the annual rainfall is higher than 350 mm((Azaizeh, et al. 2006). Due to the high demand of local and international markets for medical herbs especially during winter season, Palestinian farmers started to cultivate medical herbs for few years ago in the area of the Lower Jordan Valley. Increasing of water salinity is the major obstacle facing the development of expanding growing medical herbs. Table 1 present types of medical herbs cultivated in the Lower Jordan Valley and related cultivated area in donum (one donum is 1000 m^2)

Table 1: Medical Herbs cultivated area in the lower Jordan Valley for five years (2009-2013)

Herbs Type	**Area in dunum**
Mint	20
Tarragon	10
Oregano	12
Sage	15
Basilica	71
Rosemary	50
Oregano (Persian)	18
Total	196

Using saline water for irrigation changes the soil structure, decreases permeability and soil aeration which has bad effects on crop diversity (crop yield, crop quality …).

In order to treat saline water, the ministry of agriculture established a water treatment plant in LJV depending on the common reverses osmoses (RO) technology. This technology needs high investment, replacement parts, chemicals, electricity, and brine products.

The United Stated Agency for International Development (USAID) started a pilot project of using magnetic treated water in irrigation of two medical herbs, Oregano, and Tarragon in the LJV. The main objective was to test the effect of using magnetic treated water in irrigation on the yield of these two crops under field condition. This type of treatment is expected to have a high efficient influence on agriculture production, overcome the problem of water resources limitation and salinity, and decrease the hazardous impact on the surrounded environment.

1.2 Problem Statement

For ages Al-Uja is considered to be one of the main agricultural settlements of the human species. The mild climate during winter, the fertile soil and the availability of water have made this area attractive for agricultural activities.

Nowadays, the agricultural sector in this area is facing major impediments related to the high water salinity as the salinity of groundwater increased during the past 40 years from less than 1000 µS/cm to about 6000 µS/cm due to the limitation of recharge rate over exploitation and the up conning of brines. (Marie 2001, Khayat 2006, Sobeih 2006, Amer 2013).

1.3 Objective

Major Objective

To study the impact of using MWT on yield and quality of herbs yield.

Minor Objective

1. To study the impact on irrigation infrastructure (clogging of dripper).
2. To study the impact of MW on soil salinity.

Chapter Two

Study Area

2.1 Study Area

Al-Uja is a Palestinian town in Jericho. It is located at an elevation of -220m in the west, to-280m below the sea level. Its coordination is from 151800 at the north to 196900 to the east. Its considered as a part of shallow lower eastern aquifer. Its catchment is about 170km^2. The annual amount of direct rainfall reaches about 156mm in this area.

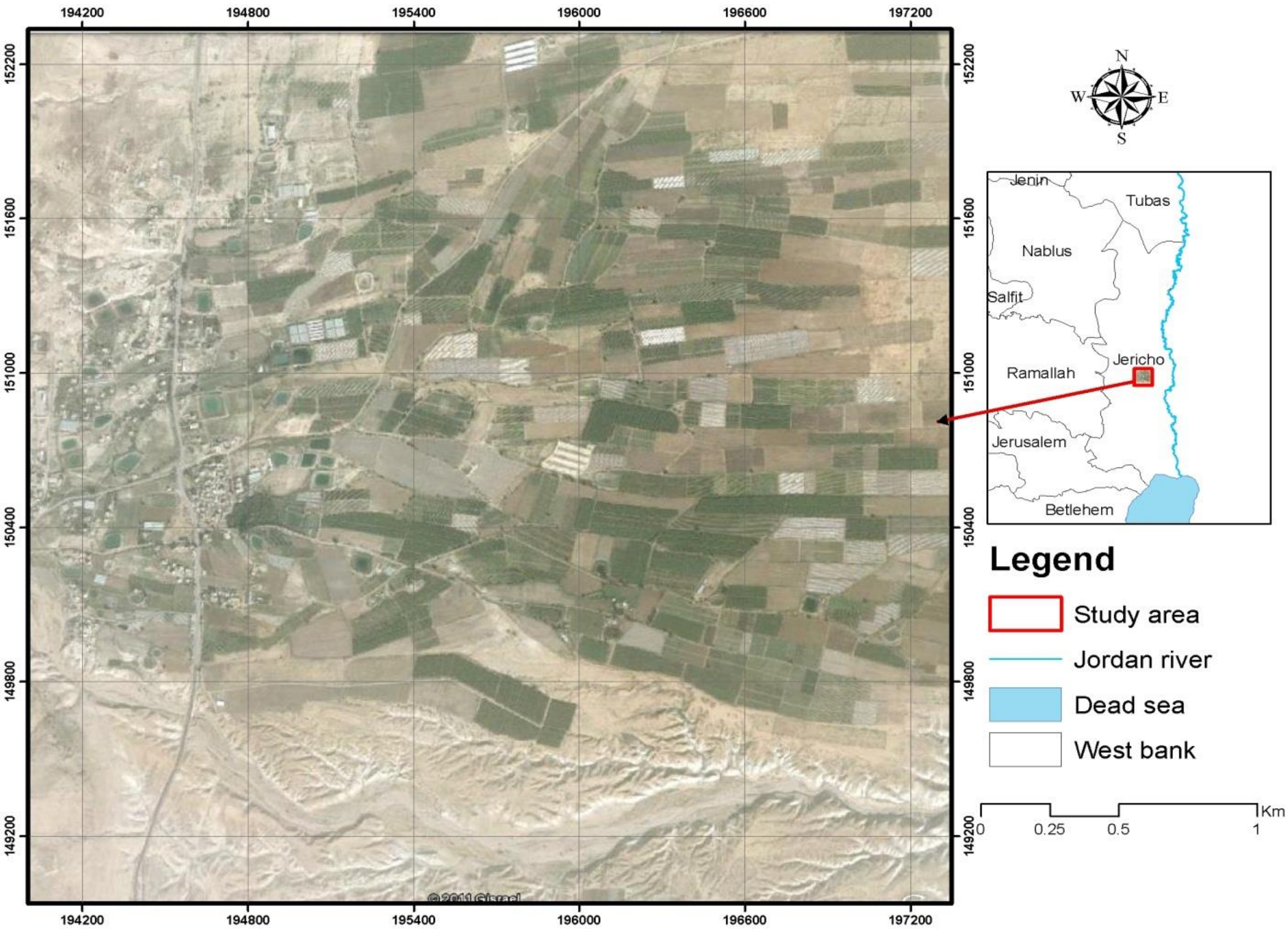


Figure 1: Geographical map for the study area location.

The combination **of** its location, warm weather and availability of water, makes AL Uja one of the main important centers of agriculture.

Less than 5000 capita live in AL Uja. They depend on spring water for domestic and agricultural use. In this agricultural community, there are around 9 agricultural wells. Unfortunately the water in these wells is highly saline. (PWA, 2008).

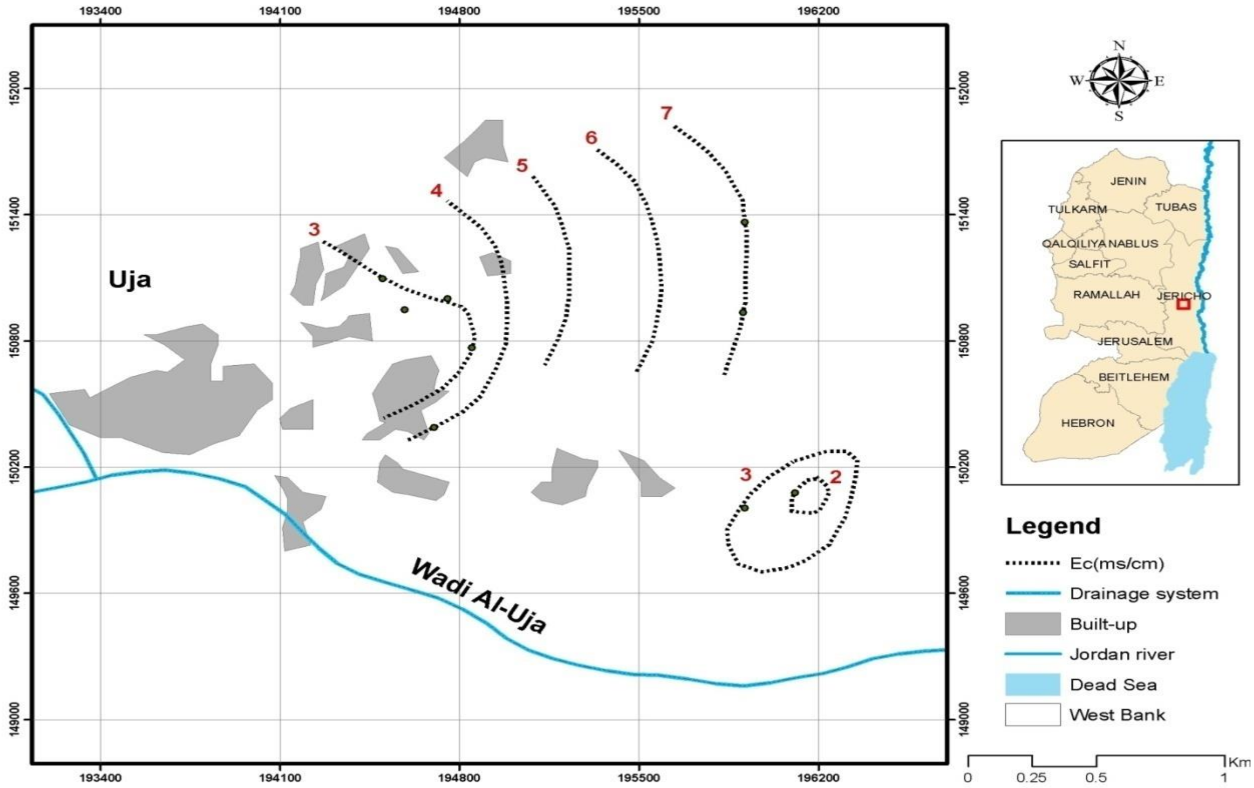


Figure 2: Salinity distribution in Al Ujaarea, SMART-project (Marei.A, et al 2011).

2.2 Geology of the Area

AL-Uja has various geological formations. Alluvium formation, Lisan and Samra formation, and chalk and chert formation are the main dominant formations of this area. The climate of Al Uja area is classified as arid which has hot summers and warm winters.

Chapter Three

Literature Review

3.1 Magnetic Water Technology (MWT)

Magnetic water technology is a new technology which is used to overcome the high salinity in irrigation water. This technology requires less investment, is decentralized and mobile, requires minimum replacement parts, has a low maintenance cost and uses solar clean energy. Discovery of magnetic water therapy back to 1803 by natural magnetic rocks. Faraday (1863) started researches on MW treatment. Since then a lot of researches have been done. The MWT is based on the vibration of water molecules that surrounds the salts ions, which splits the water molecules cluster. Therefore, the entrapped salt particles become unbound and have the ability to move outside the water cluster.

The magnetic water also allows the salt particles to form nucleation centers. This centers form platelets that avoid the formation of hard crystal residual. Converted dissolved minerals under saturated condition into a mixture of micro crystal (under saturation) allow the water to dissolve additional minerals through its pathway. This phenomena can be utilized for opening clogged drippers and for washing salts from the upper soil horizon. Another characteristic of treated magnetic water is its low surface tension, which allows the water move faster within the upper soil horizon penetration the soil quickly and reaching the plant uptake zone in a shorter period. Also, the reduction of surface tension may increase water absorption through the cell wall and thus accelerate the growth rate of the growing part of the plant (Kronenbreg 1985, Parsons 1997, Banejad. and Abdosaleh 2009).

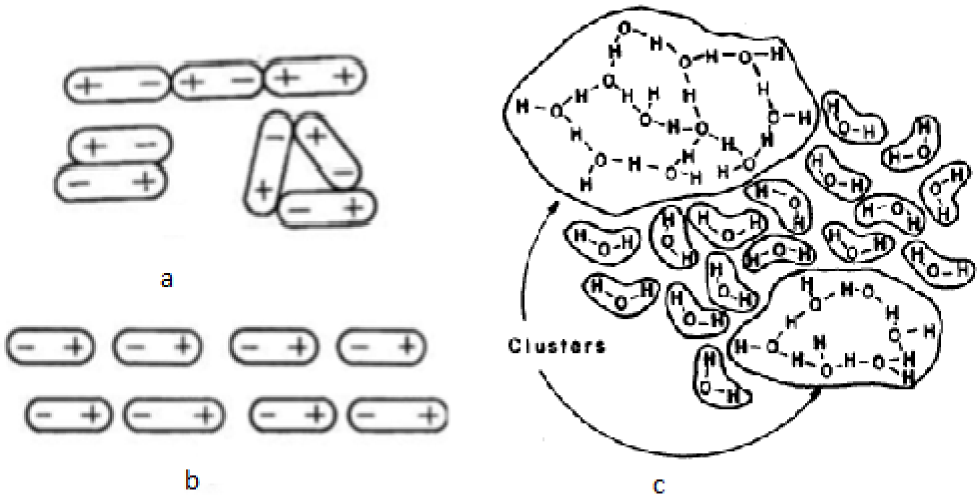


Figure 3: Water molecules. Dipole Effect of magnetic field on water molecules: a-thermodynamically stable water clusters, b-water molecules after passing through a magnetic field. c- Structure of molecule cluster of water. (Mcmahon, 2009)

The following tables show the differences between magnetic water and reverse osmosis treatment in several aspects.

Table 2: Magnetic water treatment versus reverse osmosis

Comparison aspect	Magnetic Water	Reverse Osmoses
Investment	Low	High
Mobility	Yes	No
Infrastructure	Low Investment	high Investment
Energy	Solar Energy	Electricity Network
Maintenance	Doesn't need	Need
Impact on Environment	Eco-friendly	Produce Brine water
Sustainability	Average Life time is high	Average Life time is Low

	Initial Cost	Infrastructure	Energy/m^3	Chemicals
Reverse Osmoses	150000$	10000$	0.4kw/m^3	1L of anti-calcination 8$/day
Magnetic water	25000$	1000-3000$	0.0	0.0

3.2 Previous Studies

There are many previous studies that are conducted to examine magnetic water and its use in many areas such as industry, agriculture and day life. Some of these studies and their result are illustrated as follow:

- **Lin, 1990;** magnetic treatment affects the quality of irrigation and drinking water. It was shown that treated water contributes to increase in farm yields in both livestock and crop farming yield being expressed in the quantity and quality of the production and in the specific economic contribution.
- **Muraji et al. 1992** studied the effect of exposing the maize seedling, and he reported that the highest growth rate of maize roots to 5 mT magnetic fields, of the root growth.
- **Kinouchi, Yamaguchi et al. 1996; Aladjadjiyan 2002; Esitken 2003** reported that using of magnetic water can decrease the soil alkalinity, increase the mobility of fertilizers, and increase the yields.
- **Parsons,1997**; Experiments have focused on establishing whether magnetism has an effect on calcium carbonate precipitation and, if so, identifying the parameters promoting magnetic amelioration of scaling. The research programme comprised a fundamental and systematic study of the magnetic effect on scalants such as calcium carbonate in which strict control of critical parameters were maintained
- **Bogatin, Bondarenko et al. 1999** studied the effect of magnetic treatment of irrigation water on the quality of irrigation, and he found that the flow rate through the apparatus, water carbonate hardness of more than 50 mg and pH value of more than 7.2 are important factors affecting the impact of treatment.
- **Brower,2005;** when a properly designed magnetic water system is correctly sized, installed and maintained on a cooling tower or any water-using equipment within its limitation, hard water scale and corrosion can be controlled at least as effectively as any other method presently being used in the industry.
- **Amiri,2005;**investigatethe validity of reduction surface tension of water due to magnetic field treatment .
- **Alami Fathi,2006;** the effect of magnetic field on the precipitation process of calcium carbonate scale from a hard water was studied. It was shown that the

magnetic treatment increases the total amount of precipitate. This effect depends on the solution pH, the flow rate and the duration of the treatment.

- **Ali Fathi,2008;**to study the effect of a magnetic water treatment on homogeneous &heterogeneous precipitation of Calcium Carbonate.
- **Selim,2008;**evaluate the effectiveness of magnetizing underground brackish water to increase the applicability of water for irrigation, salts accumulation in soil, mobility of nutrients elements in root zone
- **Nasher, 2008**; reported also an increase on the growth of chick-pea crop.
- **Banejad, 2009;** to survey of magnetic field effects on changing of water hardness. This research has considered effect of changing of magnetic field intensity, and amount of water influent on water hardness reducing.
- **Maheshwari, 2009;** his study examines weather there are any beneficial effects of magnetic treatment of different irrigation water types on water productivity and yield of snow pea, celery and pea plants. The results indicate that there are some beneficial effect of magnetically irrigation water, particularly for saline water and recycled water, on yield and water productivity of celery and snow pea plants and controlled environmental condition.
- **Toshiaki Osuga, 2009;** elucidate the magnetic field transfer and relate it to experimental finding.
- **Ran Cai, 2009;** study the impact that magnetic treatment exerts on water microstructure using proton NMR spectroscopy. The magnetic water treatment was used to examine the effects on the physiochemical properties (surface tension & viscosity) of water passing through a magnetic field orthogonally in circulation, & determine the formation of hydrogen bond and the restructure of water cluster based on the change of water intermolecular energy. Finally, the present data demonstrated the variation of the mean size of water clusters after magnetic treatments.
- **Amira.m.s, 2010;** to study the effect of irrigation with magnetized water on growth, yield, yield components and some chemical constituents of lentil under greenhouse condition.
- **Hozayn,2010;** his work was carried out to study the response of growth, yield, yield components and some chemical constitute of wheat for irrigation with magnetized and tap water under greenhouse condition during 2008/09 and2009/2010 winter seasons. He concludes that magnetized water treatment

increased yield and yield component at harvest and improved quantity of wheat crop.

- **Abdul Qados,2010;** she compares between irrigation with magnetize and tap water on growth, yield, yield components and chemical constituents of lentil. Irrigation lentil plant with magnetized water significantly improvement the most above mentioned parameter compared with tap water.
- **Abdul Qados 2011;**also reported an improvement irrigated Lentil plant with treated magnetic water in term of plant height, fresh and dry weight, water contents chlorophyll a , a+b, total pigment, total phenol.
- **Al-khazan,2011;**investigate the biological effect of magnetically treated water under different water regimes on water relations ,photosynthetic pigments and nutrients of jojoba plants.
- **Mustafazadeh-Fard, 2011;** this study was performed to investigate soil moisture under trickle irrigation. The study concludes that irrigation with magnetic water as compared with the nonmagnetic water increased soil moisture up to 7.5%. And it recommended using magnetic water for irrigation in order to save irrigation water.
- **Ul Haq, Jamil et al. 2012:** reported also an increasing in seedling growth, yield, plant height, root mass of Radish using Pre-sowing magnetic field water treatment.
- **Pirzad, Shokrani et al.2013**:reported an improvement of using magnetic saline water on germination and seedling growth of Lathyrus Sp.

Chapter Four

Methodology

4.1 Selection of Site

The pilot project was carried out in cooperation with THIMAR-company in Al Uja area. For each crop (Oregano, and Tarragon) two greenhouses were selected to study the effect of using magnetic treated water in irrigation. The selection criteria followed the randomized experiment design, where 500 m^2 greenhouse was selected as treated and also the same area as controlled studies (Table 3). To avoid any effect of treated water on the control greenhouses, treated greenhouses were irrigated through a separate irrigation system.

The soil pH-value was 7.5, the electrical conductivity of the soil was 550 µS/cm. Soil consist of 44% sand, 42% silt and 14% clay, and the soil texture consider Loam to clay Loam soil type. This pilot project study is one five USAID- pilot projects sites across the LJV for studying the effect of using treated magnetic water in irrigation of different crops (Bell Pepper, Grapes, Date trees, Beans) .

Table 3: Characteristic of herbs pilot project site in Al Uja

Item	Description	Item	Description
Soil type	Loamy soil	Type of cover	Greenhouse
Water salinity	3.45 mS/cm	Growing duration	September 2012 until April 2013
Total volume of irrigated treated water	650 m^3/donum	Total volume of irrigated non treated water	650 m^3/donum
Irrigation method	Drip irrigation	Water salinity	3.45 mS/cm
No. of traced treated Plants	25	No. of traced control Plants	25

Four blocks of land were selected to conduct the Oregano and Tarragon plantation. Two blocks were irrigated with treated magnetic water, where the second two blocks were irrigated with non-treated water. The four blocks were handled under the same conditions concerning fertilizers, pesticides, except using treated magnetic. Water salinity was checked in the field in a regular base every 10 days, where no remarkable changes in the salinity is noticed

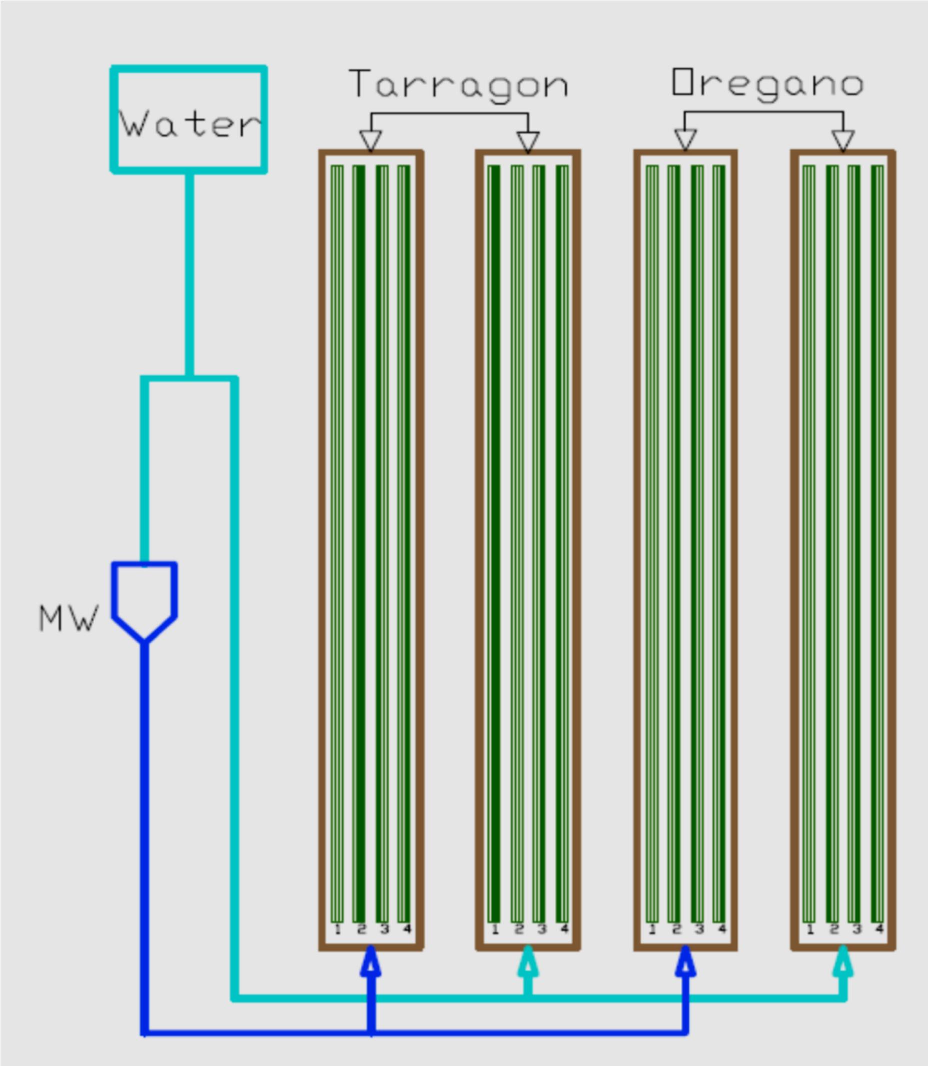


Figure 4: Explanatory Map of the location.

4.2 Magnetic Treatment

Water taped from 110 m deep borehole was used for irrigation with an average temperature of 18 ºC. Average groundwater salinity was 3.45 at 25 ºC. This water pass through a magnetic device from Aqua 4-D (Swiss company) in a rate of 15 m^3/h, while the maximum treatment capacity for this device is 20 m^3/h (2 inches, output 20 m^3/h). Magnetic water had to flow only 5 to 15 meters distance to reach the target greenhouses because the water preserve its magnetic properties only a period not exceed 2hr.

Pretreatment of both sites was carried out before plantation of Oregano and Tarragon seedling tock places. Figure 5 show the Aqua 4D.

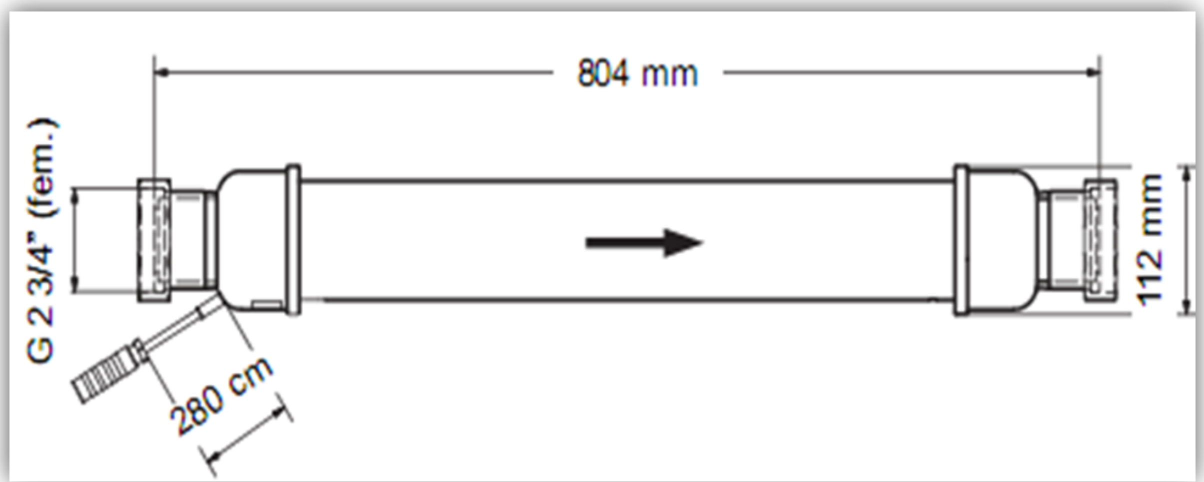


Figure 5: Aqua 4D

The plantation was conducted at the 21 of September 2012 and 10 of October 2012 for Tarragon and Oregano respectively, where the first harvesting date was at 4 of December 2012 and 3 of January 2013 respectively. Representative seedling were randomly selected to present the growing cob, these were traced. All monitoring parameters were carried out on these traced seedling. In order to be sure that the number of seedlings is representative, measurements of seedling height were carried after 20 days of plantation and the final number of traced seedling was fixed for the rest of the pilot project. We decided to accept an error of 5% for seedling height, where the following formula was used:

$$m = \left(\frac{C_v}{e}\right)^2$$

$$Where:$$

$$m: the\ optimum\ number\ of\ samples$$

$$e: is\ the\ degree\ of\ error. (5\%)$$

$$C_v: is\ the\ coefficient\ of\ variation\ is\ determined\ by:$$

$$C_v = (\sigma/\bar{x}) * 100\%.$$

$$Where\ \sigma: is\ the\ standard\ deviation.$$

$$\bar{x}: is\ the\ average\ of\ sample.$$

4.3 Irrigation Scheduling

Drip irrigation method is used in watering the Herbs seedlings. The irrigation scheduling was applied by the farmer in a form business as usual. The volume of treated magnetic water applied per donum of Herbs was 650 m^3/donum for treated and 650 m^3/donum of non-treated water for controlled block the water volume was measured using flow meter. During the same period, the same recommended NPK fertilizers were applied equally to both treated and controlled blocks.

4.4 Laboratory Work

Chlorophyll content and weight of fresh root mass were carried out at the Environmental Research laboratory at Al Quds University (AQU) (Table 4). Herbs roots were cleaned with water from soil, and then dried at 25° C room temperature before weighting.

4.5 Data Collection and Analysis

Plant height, number of branches (major and minor), yield were observed in the field, where chlorophyll content, root mass, and shelf time were carried out at the Environmental Research lab at Al Quds University (AQU) (Table 4). The volume of water used in irrigation of controlled and treated blocks was calculated based on m^3/donum area. Water productivity was calculated based on fresh weight of Herbs in kg/m^3 of water used. Monitoring of crop height, number of major branches were conducted manually in the field. SPSS-software (Coakes and Steed 2009) was used in analyzing the collected data, where t-test and t-samples paired test was applied.

Table 4: Type of measurements carried on Herbs crop

Parameter	Method
Plant height,	Metric method in the field
Number of branches	Manually counting in the field
Dry weight of root	Using balance with uncertainty of 0.5gm
Shelf time	Using special bag to conserve the herbs in refrigerator

4.6 Soil Analysis

To study the effect of MW on soil salinity few samples of soil were taken from different depths, drained and grounded. Then for each soil sample distilled water was added in amass volume ratio of (1:5) for example 10gm soil to 50 ml water, each sample was shake vigorously for few minutes to ensure that all salts were dissolved. The mixtures was then allowed to settle down for about 2hours before testing.

- **Soil Salinity(soil EC):**

  EC meter (AD32 EC (shown in figure 6) was used to measure soil electrical conductivity.

Figure 6: AD32 EC

- **Measure of Major Elements in Soil:**
  - ✓ **Measuring Sodium, Magnesium, and Calcium:**

  For measurement the concentration of Na^{+}, Mg^{+2} and Ca^{+2}. the soil solution was filtered off, and the filtrate was examined using atomic absorption spectrometer.

  - ✓ **Measuring Chlorine:**

  For measurement the concentration of Cl^{-}. the soil solution was filtered off, and the filtrate was examined via precipitation titration using silver nitrate.

4.7 Total Chlorophyll Content

The chlorophyll content was evaluated using 10 replicates according to Arnon (1949) 0.2 g pieces of fresh leaves was added to 10 ml acetone (80%), incubated for 30 minutes in ultrasonic bath, followed by overnight incubation at room temperature. then incubation was for 30 minutes in Ultrasonic bath, second addition of 10 ml acetone

80%, for the third time the solution was incubated for 30 minutes in ultrasonic bath and finally incubation for 4 hours, followed by 30 minutes in ultrasonic bath.

The volume of the supernatants was completed with acetone (80%) to 50 ml. Detection was carried out at 645 nm and 663 nm using spectrophotometer.

Recorded numbers were applied on the following equation:

mg chlorophyll /0.2gm fresh weight =20.2A645nm +8.02A663nm

Then the values were calculated for 1 gm fresh weight by dividing them on 0.2.

4.8 Dry Biomass

Two methods were used:

- ✓ Using oven:
  Plant samples (each sample about 100gm) was dried in oven at 85C for 24 hours
- ✓ Samples were dried at room temperature for few days.

4.9 Statistical Analysis

Two types of test were used ; these are 1. Independent -t- test: the normality assumption of the studied parameters is tested according to (Shapiro and Wilk 1965), if its normal distributed, the independent t-test was applied, and when it's not normally distributed the equivalent nonparametric test was applied (Mann-Whiteny test (Tallarida and Murray 1986). The second one is the Related test: in this method the normality assumption of the studied variables was tested according to Shpiro Wilk test. The appropriate test was used to check the difference between each variable in control and treatment samples, if its normal distributed, the paired sample t-test was used, and when the distribution was not normal the equivalent nonparametric test was applied (Wilcoxon Test).

Chapter Five

Results and Discussion

The impact of using magnetic water treatment on herbs crops, soil properties was observed over the full growing season and the results here shown this impact.

5.1 Yield of Crops

There was a clear positive effect of using magnetic treated water on the yield based on its weight. The yield of one donum irrigated with treated magnetic water was 990 kg and for the controlled greenhouse was 784 kg for Oregano crops. The irrigation of Oregano crops with magnetic treated water caused an increase of about 26% in the Oregano. On the other hand, the yield of one donum irrigated with treated magnetic water was 1361 kg and for controlled greenhouse it was 1295 kg for tarragon crops, the irrigation of Tarragon with magnetic treated water caused an increase of about 5% in the Tarragon even though of the number of seedling in treated unit is less than that in controlled unit. Yield on fresh weight is shown in Table 5.

Table 5: Cultivated area, number of seedling, and yield in kilogram

	Oregano		Tarragon	
	Control	Treated	Control	Treated
Area in donum	0.5	0.5	0.5	0.5
No. of seedling in greenhouse	6571	6605	6350	5650
Yield in kg /donum	784	990	1295	1361
Difference kg/donum	206		66	
Difference in %	26%		5%	

5.2 Water Productivity

Water productivity is defined as the crop yield per unit volume of water.

For Oregano, the total water production per one cubic meter of water during the growing season 2012/2013 was 1.5 kg/m^3 for treated, and 1.2 kg/m^3 for controlled greenhouse. This result shows that there is a clear increase in the water productivity based on the yield by applying magnetic treated water. Based on 2009 published data from the Palestinian Statistical Bureau, 12 donum of Oregano were growing under greenhouses condition in the Lower Jordan Valley. Assuming that the average yield could be 990 kg/donum, then the total production could be (990*12) 11880 kg of Oregano. According to the pilot project, a total increase in the yield of about 2472 kg could be expected by using treated magnetic water.

For Tarragon, the total water production during the growing season 2012/2013 was 2.1 kg/m^3 for treated, and 2 kg/m^3 for controlled greenhouse. This result shows that there is a slight increase in the productivity of the yield by applying magnetic treated water. Based on 2009 published data from the Palestinian Statistical Bureau, statistics showed that 10 donums of Tarragon were growing under greenhouses condition in the Lower Jordan Valley. Assuming that the average yield could be 1361 kg/donum, the total production could be (1361*10) 13610 kg of Tarragon. According to the pilot project, a total increase in the yield of about 660 kg could be expected by using treated magnetic water.

To conclude if the herbs were irrigated by magnetic water, the yield will increase and so the economic income will increase. The average price of one kg of Oregano is 16 NIS, and for Tarragon it is 24NIS. If all planted areas (with Tarragon and Oregano) are irrigated with MW, the economic income will increase by 39552NIS (about 11632US$) for Oregano, and 15840NIS (about 4658US$) for Tarragon herbs.

5.3 Dry Weight of Roots

Applying magnetic treated water had also positive significant effect on the biomass of Oregano and tarragon fresh weight roots, for it had an increase of about 6.4% in treated Oregano fresh weight roots compared to the controlled Oregano, while for Tarragon it had an increase of about 19.4% in treated tarragon fresh weight roots compared to the controlled Tarragon. The sample we had treated gives average weight of fresh root biomass irrigated with treated magnetic water 79.2 gm compared with 69.95gm of non-treated Oregano on the other hand the average for the Tarragon irrigated by magnetic water was 51.4g and that for non-treated tarragon was 34.8gm. Table 6and table 7 shows the root biomass in gram for both Oregano and Tarragon respectively.

Table 6: Treated and controlled root bio-mass in gram for Oregano.

Date/samples		No. of samples	Biomass for root (m± δ)gm
29/5/2013	Treated	5	91.0±23.3
	Control	5	93±34.9
1/6/2013	Treated	5	30±9.5
	Control	5	31±16
5/6/2013	Treated	4	84.3±22.3
	Control	4	64.5±34.4
11/6/2013	Treated	5	113.8±26.6
	Control	5	90.2±28.6
Average	Treated	19	79.2±39.1
	Control	19	69.95±39.9

Table 7: Treated and controlled root bio-mass in gram for Tarragon

Date/samples		No. of samples	Biomass for root (m ± δ)gm
11/6/2013	Treated	34	51.4±29.3
	Control	28	34.8±22.6

5.4 Shelf Time

We selected 100 grams randomly from each sampling campaign (100gm from each herb) (Table 8). We stored the samples at 4 ºC. After about twelve days of storing, the Oregano and Tarragon samples were evaluated optically. The results of this experiment was not clear, because it depends on the optical observation of the herbs which is a difficult procedure. In general both treated and control samples got damaged within the same period of time. Table8 and table 9 show the duration for both Oregano and Tarragon respectively.

Table 8: Sampling date, and duration of Shelf time ant 4 ºC for Oregano

Date of sample	Type of sample	Date of damage
15/1/2013	T	27/1/2013
	C	27/1/2013
20/3/2013	T	2/4/2013
	C	2/4/2013
4/8/2013	T	16/8/203
	C	16/8/2013

Table 9: Sampling date, and duration of Shelf time ant 4 ºC for Tarragon

Date of sample	Type of sample	Date of damage
31/1/2013	T	10/2/2013
	C	10/2/2013
13/3/2013	T	25/3/2013
	C	25/3/2013
18/4/2013	T	29/4/2013
	C	29/4/2013
15/5/2013	T	1/6/2013
	C	1/6/2013

5.5 Plant Morphology (Height and Major- and Minor Branches)

5.5.1 Oregano Morphology

The height of representative seedling samples was measure in the field. Table 10 summarized a comparison between the treated and the controlled samples. There is no significant difference in the height between treated and control samples. on the other hand, there is a significant difference (less than 0.05) between the number of major branches for the advantage of treated seedling during the sampling campaign 20-11, 28-11, 5-12, and 12-12/2013. This means that the number of major branches of the treated Oregano seedling is more than that of controlled seedling. By comparison it was found that there is no significant difference between the minor branches between treated and controlled samples.

Table 10: Summarized results of different parameters (H: height, Major branch, Minor branch of Oregano

	Independent T-test		Related Samples test	
Variable	Significant value	significant or not	Significant value	significant or not
H1	0.182	not significant	0.222	not significant
H2	0.273	not significant	0.143	not significant
H3	0.883	not significant	0.627	not significant
H4	0.128	not significant	0.147	not significant
H5	0.216	not significant	0.153	not significant
H6	0.613	not significant	0.513	not significant
Major B1	0.878	not significant	0.630	not significant
Major B2	0.027	**significant treatment>control**	0.062	not significant
Major B3	0.002	**significant treatment>control**	0.019	**significant treatment>control**
Major B4	0.001	**significant treatment>control**	0.009	**significant treatment>control**
Major B5	0.000	**significant treatment>control**	0.014	**significant treatment>control**

Major B6	0.001	**significant treatment>control**	**0.022**	**significant treatment>control**
Minor B1	0.213	not significant	0.151	not significant
Minor B2	0.953	not significant	0.775	not significant
Minor B3	0.082	not significant	0.128	not significant
Minor B4	0.332	not significant	0.502	not significant
Minor B5	0.225	not significant	0.219	not significant
Minor B6	0.264	not significant	0.191	not significant

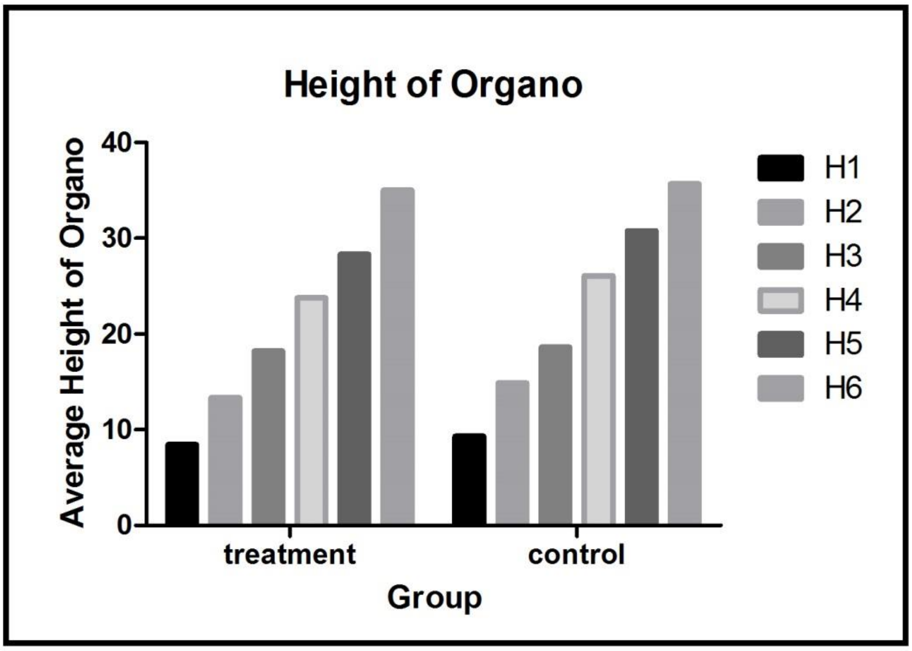


Figure 7: Height of Oregano for both control and treatment group

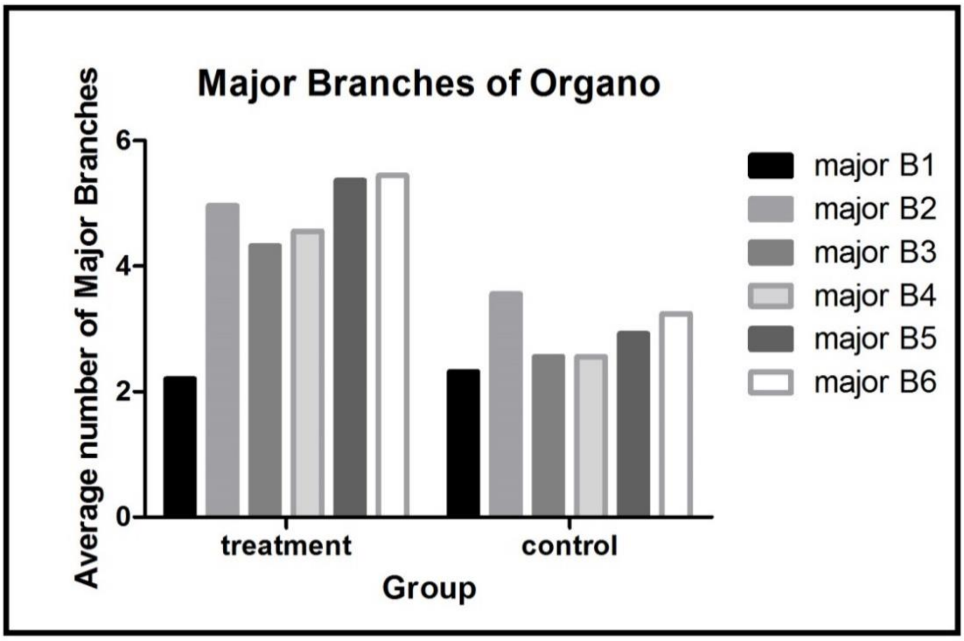


Figure 8: Number of major branches of Oregano for both treatment and control group

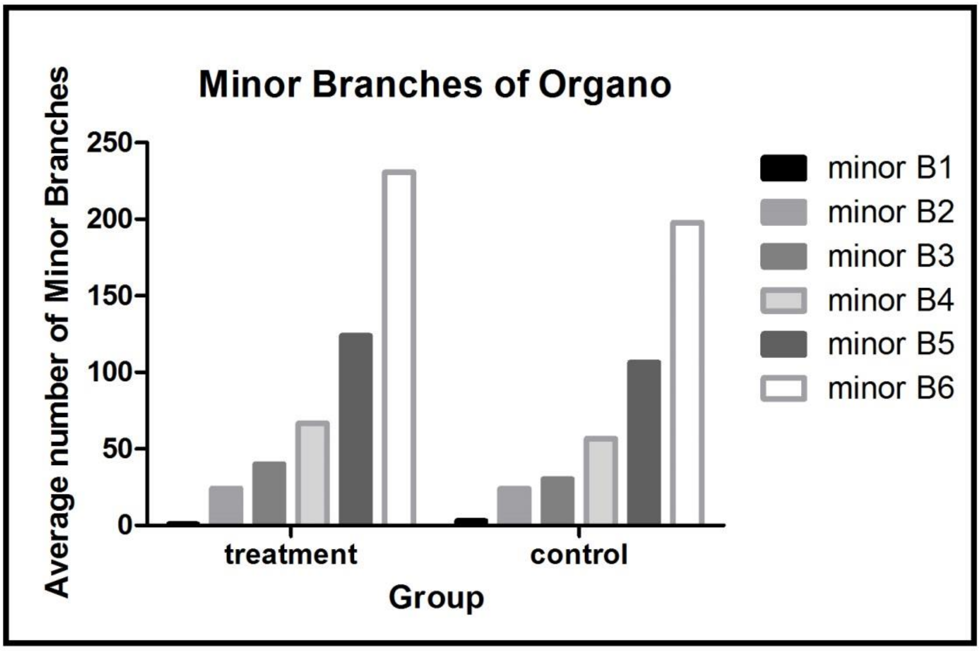


Figure 9: Number of minor branches of Oregano for both treatment and control group

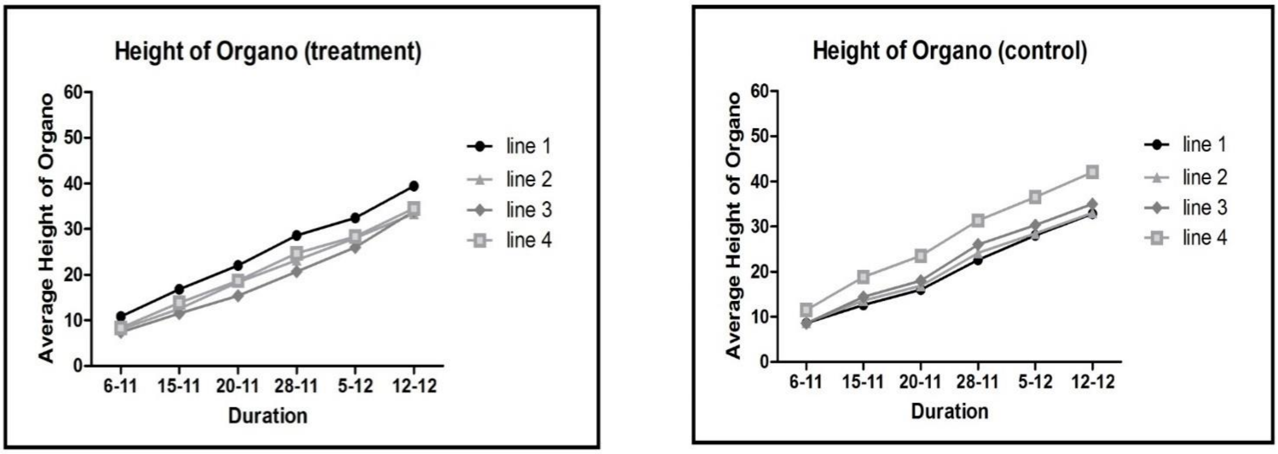


Figure 10: Growing rate for both treatment and control group

5.5.2 Tarragon Morphology

The height of representative seedling samples was measured in the field. Table 11 summarized a comparison between the treated and the controlled samples. we can see that for the studied variables, the height of the tarragon at 22-10 between control and treatment group was significant as sig = .028 and it's less than .05, which means there is a significant differences between the length of the tarragon at 22-10 in the control and treatment group, but there is no significant difference in the height and number of major and minor branches between treated and control samples.

Table 11: Summarized results of different parameters (H: height, Major branch, Minor branch) for Tarragon

Variable	Independent T samples		Related Samples	
	Significant value	significant or not	Significant value	significant or not
H1	0.028	significant (control>treatment)	0.029	significant (control>treatment)
H2	0.075	not significant	0.106	not significant
H3	0.056	not significant	0.172	not significant
H4	0.702	not significant	0.728	not significant
H5	0.424	not significant	0.298	not significant
H6	0.487	not significant	0.383	not significant
Major B1	0.422	not significant	0.323	not significant
Major B2	0.959	not significant	0.769	not significant
Major B3	0.370	not significant	0.266	not significant
Major B4	0.467	not significant	0.373	not significant
Major B5	0.306	not significant	0.317	not significant
Major B6	0.174	not significant	0.197	not significant
Minor B1	0.520	not significant	0.510	not significant
Minor B2	0.167	not significant	0.459	not significant
Minor B3	0.448	not significant	0.216	not significant
Minor B4	0.921	not significant	0.945	not significant
Minor B5	0.760	not significant	0.898	not significant
Minor B6	0.268	not significant	0.183	not significant

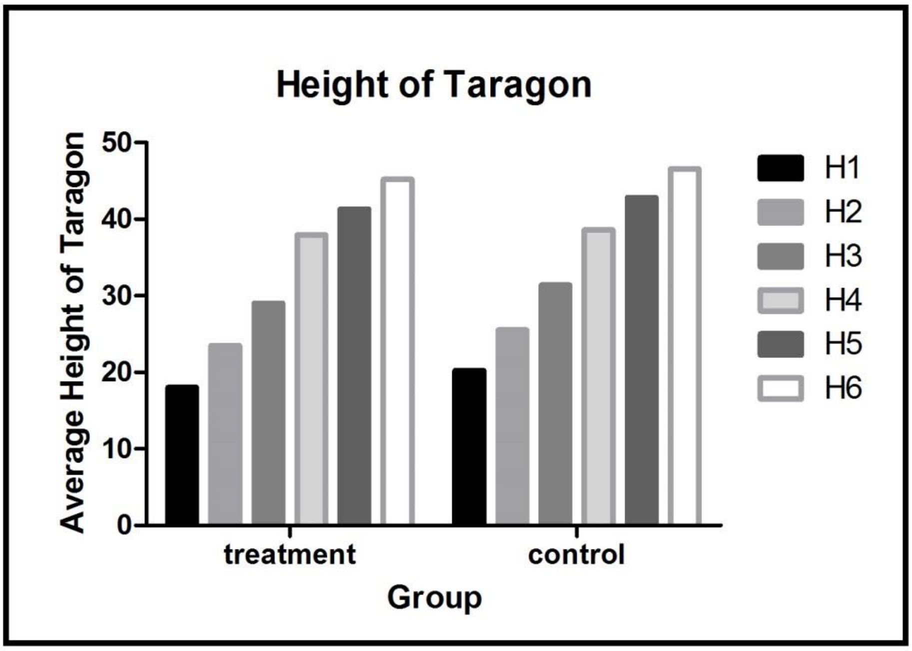


Figure 11: Height of Tarragon for both control and treatment group

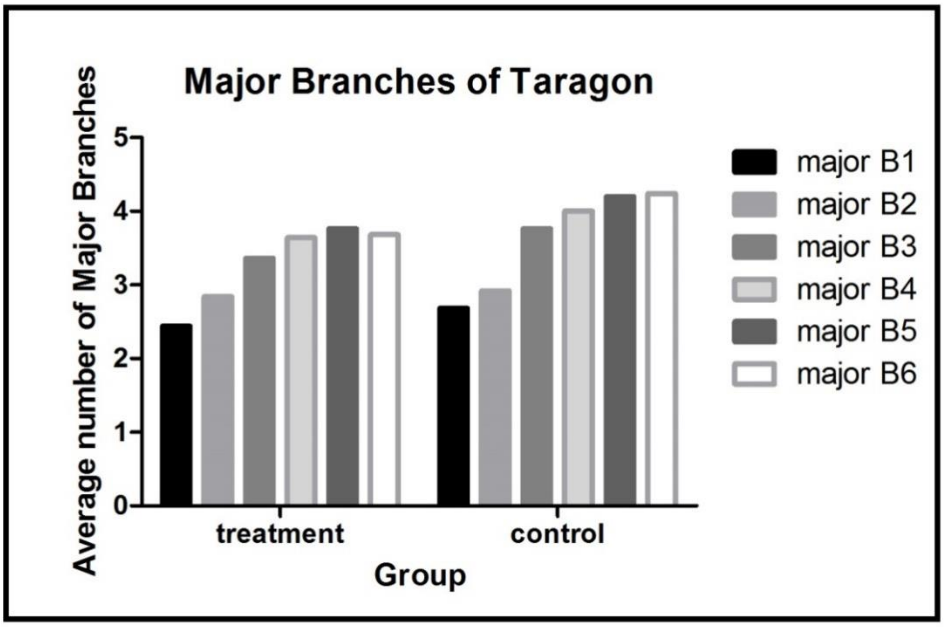


Figure 12: Number of major branches of Tarragon for both treatment and control group

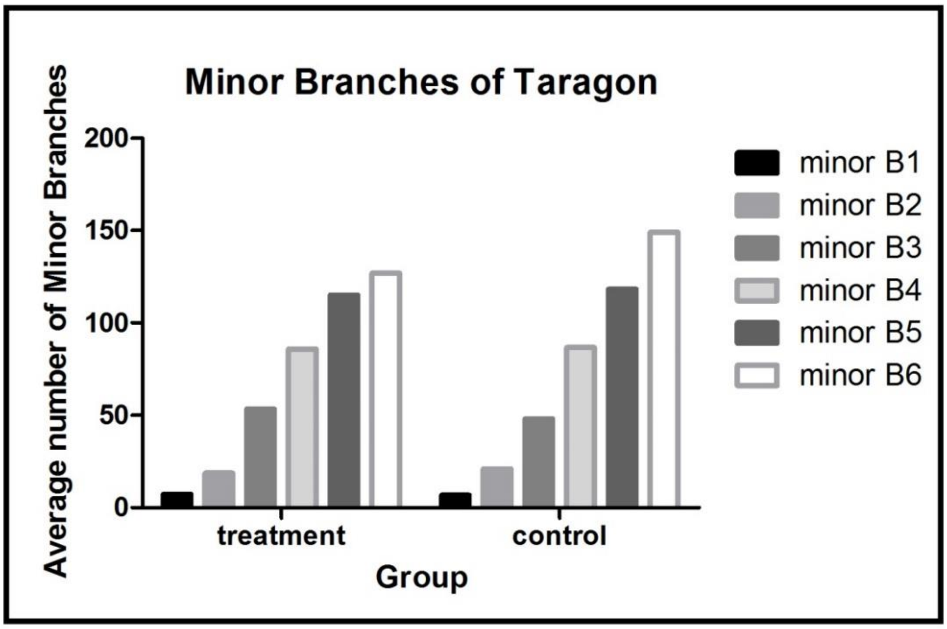
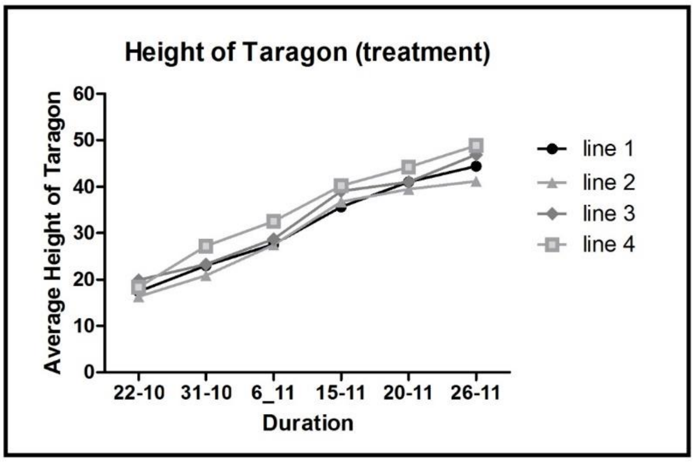


Figure 13: Number of minor branches of Tarragon for both treatment and control group



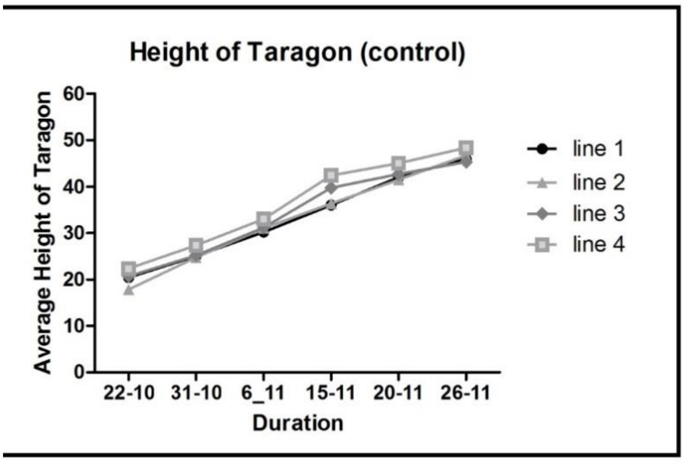


Figure14: Growing rate for both treatment and control group

5.6 Dried Biomass

5.6.1 Dried Biomass for Oregano:

Three fresh Oregano samples were dried at 25 ºC (room temperature) for twelve days. Table 10 presents the fresh and the dry weight after twelve days in gm. The result indicates that treated Oregano samples contain higher percentage of water from its weight. It's lost about 60% from its weight, where the lost by the controlled samples was 56%. This phenomena can explain the high treated crops yield, that because the treated samples contains higher water amount than the controlled samples. So it's recommended to sell fresh herbs and not dried ones. Table 12 shows the biomass of fresh and dried of Oregano herbs.

Table 12: Biomass of fresh and dried Oregano Herbs after 12 days

Date of sample	Type of sample	Fresh weight (gm)	Dray weight (gm)	% of weight lost
15/1/2013	T	100	40	60%
	C	100	45	55%
2/4/2013	T	70	30	57%
	C	70	35	50%
11/4/2013	T	100	40	60%
	C	100	45	55%

5.6.2 Dried Biomass for Tarragon:

Three fresh samples of Tarragon were dried at (25 ºC) for 30 days, and three fresh samples were dried by using oven at (85 ºC) for (24 h). The results indicate that treated Tarragon contains higher percentage of water. It lost about 86.9% of its weight while the lost by controlled sample was 85.5% of its weight. Table 13 shows the biomass of fresh and dried of Tarragon herbs.

Table 13: Biomass of fresh and dried of Tarragon Herbs.

Date of sample	Type of sample	Fresh weight (gm)	Number of sample	Dray weight (gm)	% of weight lost
13/3/2013	T	100	3	13.9	86%
	C	100	3	14.4	85.6%
13/3/2013 (by oven)	T	100	3	12.3	87.7%
	C	100	3	14.7	85.3%

We can explain that the treated Tarragon and Oregano samples contain higher percentage of water by referring to the principle of work of magnetic water treatment, as mentioned in the literature review. The treated water has law surface tension which allows the water to move faster within the upper soil horizon penetrating the soil quickly and reaching the plant uptake zone in a shorter period.

5.7 Chlorophyll Contents

5.7.1 Chlorophyll Contents for Oregano

Four random bulk samples of Oregano leaves were collected and analyzed for its total Chlorophyll contents. Results are tabulated in table 14, where in the average chlorophyll contents in treated leaves were 1.86 mg/0.2gm and for the controlled leaves were 1.34 mg/0.2gm. Finding results show that there is a significant difference (less than 0.05) between Chlorophyll content between treated and controlled sample for the advantage of treated samples. That because MW has Lower surface tension, which allows water and nutrients to move faster within the upper soil horizon and reach the root zone in a shorter time. Also reducing the surface tension will increase water absorption through the root cell wall and thus accelerating the growth rate of the growing parts of the plants.

Table14: Total Chlorophyll contents in mg/0.2gm for Oregano

Date/samples		Chlorophyll contents (mg/0.2gm)
23/5/2013	Treated	1.78
	Control	1.53
29/5/2013	Treated	1.86
	Control	1.44
5/6/2013	Treated	2.26
	Control	1.08
11/6/2013	Treated	1.53
	Control	1.31
Average	Treated	1.86±0.30
	Control	1.34±0.20

5.7.2 Chlorophyll Contents for Tarragon:

Twelve random samples of Tarragon leaves were collected and analyzed for its total Chlorophyll contents. Results are in table 15. The average Chlorophyll contents in the treated leaves were 0.42mg/0.2gm.and for the controlled leaves were 0.34mg/0.2gm. These results show that there is no significant difference between Chlorophyll contents in treated and controlled sample.

Table 15: Total Chlorophyll contents in mg/0.2gm for Tarragon

Date/samples		Chlorophyll contents (mg/02g)
23/5/2013	Treated	0.42
	Control	0.35
Average	Treated	0.42±0.10
	Control	.35±0.1

5.8 Impact of Magnetic Water on Dripper Condition

Drip irrigation is widely used in the LJV region. Palestinian farmers use this irrigation method in order to have high water revenue, and to avoid accumulation of salt on the soil surface. The discharge of each dripper depends on the water pressures, and on the condition of the dripper outlet (2 liter/hour). Changing in temperature, and pressure do not affect only the yield but also the dripper discharge volume. Groundwater in the pilot project is saturated with respect to carbonate minerals (aragonite, and calcite)(Marie and Vengosh 2001). By decreasing pressure and increasing temperature, calcite mineral will precipitate close to the dripper outlet (Hem, 1985) . After two months of irrigating Oregano, it was found that only 37 and 57 drippers from 3600 drippers were blogged under the treated and controlled conditions, respectively. This can explain that within the same period of time the number of damaged seedling was 595 and 629 in the treated and controlled conditions, respectively. For the Tarragon it was found that 105 and 230 drippers were blogged, but unlikely to what was expected, it was found that that the number of lost seedlings in treated samples compared to the controlled samples was 1550 and 850 respectively. The positive effect of magnetic water by reducing precipitation of carbonate minerals (calcite and aragonite) was reported by many authors (Parsons, Judd et al. 1997, Banejad and Abdosalehi 2009).

5.9 Soil Analysis

The effect of using magnetic water on soil properties was mentioned bellow.

5.9.1 Soil Electrical Conductivity and Salinity:

The electrical conductivity (EC)for soil was measured beneath the dripper, at distance away from the dripper and at different depth bellow the dripper. Table 16 represents the results found for the EC,for samples collected from dripper beneath for the two crops (Tarragon and Oregano) at different times.

The total dissolved solid (TDS) can be calculated by multiply the EC by 640 factor.

Table 16: Electrical conductivity and total dissolved solid beneath the dripper

Date	Type of sample	Number of sample	EC(μS/cm) $\bar{x} \pm \sigma$	TDS(ppm) $\bar{x} \pm \sigma$
29/1/2013	Control	4	492±271	315±174
	Treated	4	335±303	214±194
13/2/2013	Control	3	1177±408	753±261
	Treated	3	1030±271	659±173
6/3/2013	Control	3	986±143	632±92
	Treated	3	877±211	561±135
2/4/2013	Control	3	460±163	294±104
	Treated	3	343±138	220±88
9/4/2013	Control	4	443±270	283±173
	Treated	4	308±226	197±145
23/4/2013	Control	4	212±68	136±44
	Treated	4	198±50	127±32

The electrical conductivities of soil samples collected beneath dripper were collected and tabulated above. The results show that there was a decrease in the electrical conductivity for all samples, this decreases was supported by previous studies

(Mohamad, 2013). That is, the MW has the ability to prevent salt particles from forming hard crystal residual by allowing these salts to form nucleation centers. This converted dissolved minerals into a mixture of micro crystals under saturation. And, as a result, allow the water to dissolve additional minerals through its pathway, this cause a decrease in the TDS in the root zone.

The EC for samples at distances away from the dripper.

Table 17: The EC for samples at distances away from the dripper.

Date	Type of sample	Number of sample	Distance away from the dripperEC(μS/cm) $\bar{x} \pm \sigma$	Distance between two drippers $\bar{x} \pm \sigma$
29/1/2013	Control	4	1330±545	783±388
	Treated	4	575±336	788±498
13/2/2013	Control	3	1617±267	2450±400
	Treated	3	1507±196	1977±758

The electrical conductivities of soil samples collected at distances away from drippers and in between were collected and tabulated in table 17 above. The results show that there is a decrease in the electrical conductivity for all samples.

The EC for samples at different depths beneath the drippers:

For samples collected at different depths, it was noticed that the electrical conductivity for most treated samples decreased with increasing depth. The results are shown in table 18.

Table 18: EC for soil at different depths for both controlled and treated unit.

Date	**Type of sample**	**Number of sample**	**EC(μS/cm)**	
			15cm	**30cm**
26/3/2013	Control	1	280	280
	Treated	1	280	190
11/6/2013	Control	2	75±5	55±15
	Treated	2	55±5	65±5

22/6/2013	Control	3	233±202	87±5
	Treated	3	97±26	83±9

5.9.2 Soil major Ions

Concentrations of soil major Ions were measured for different samples at different depths. Table 19 represents the concentration of Ions (CL^-,Na^+,Mg^{+2} and Ca^{+2}) for different samples taken from three different depths from the dripper (<5cm,15cm,30cm).

Figures 15, 16, 17, and 18 represent plot of ions concentration versus depth for both controlled and treated units.

Table 19: Concentration of Chloride Sodium Magnesium and Calcium in soil sample.

Date	# of sample	Sample depth	Sample type	Cl^- [mg/L]	Na^+[mg/L]	Mg^{+2}[mg/L]	Ca^{+2}[mg/L]
22/6/2013	3	< 5cm	T	14±1	19±8	8±2	2±.5
			C	25±11	20±11	10±1	3±1
		15cm	T	16±1	20±9	8±2	2±.5
			C	26±11	20±11	10±1	3±1
		30cm	T	20±3	9±6	8±1	2.5±0
			C	25±6	12±4	15±5	4±2

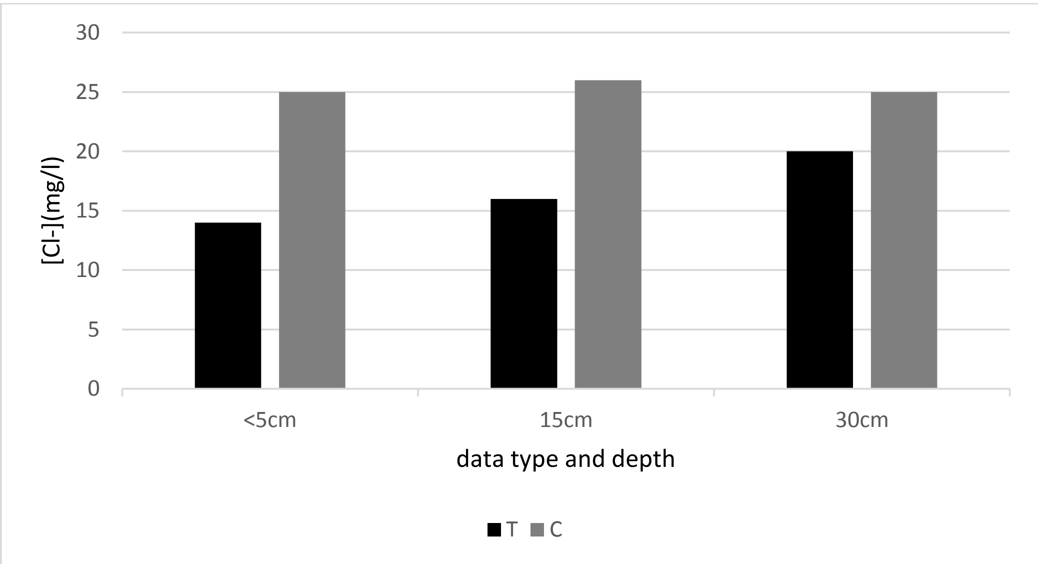


Figure15: Chloride ions concentrations in soil for both treated and controlled units at different depths.

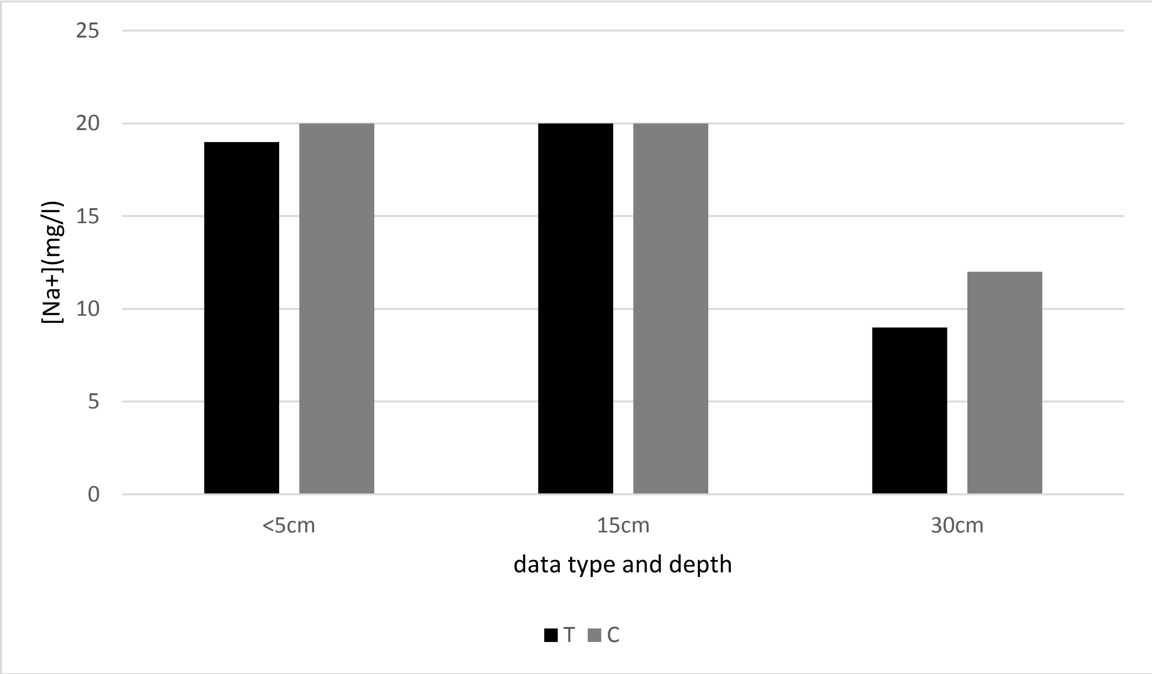


Figure 16: Sodium ions concentrations in soil for both treated and controlled unit at different depths.

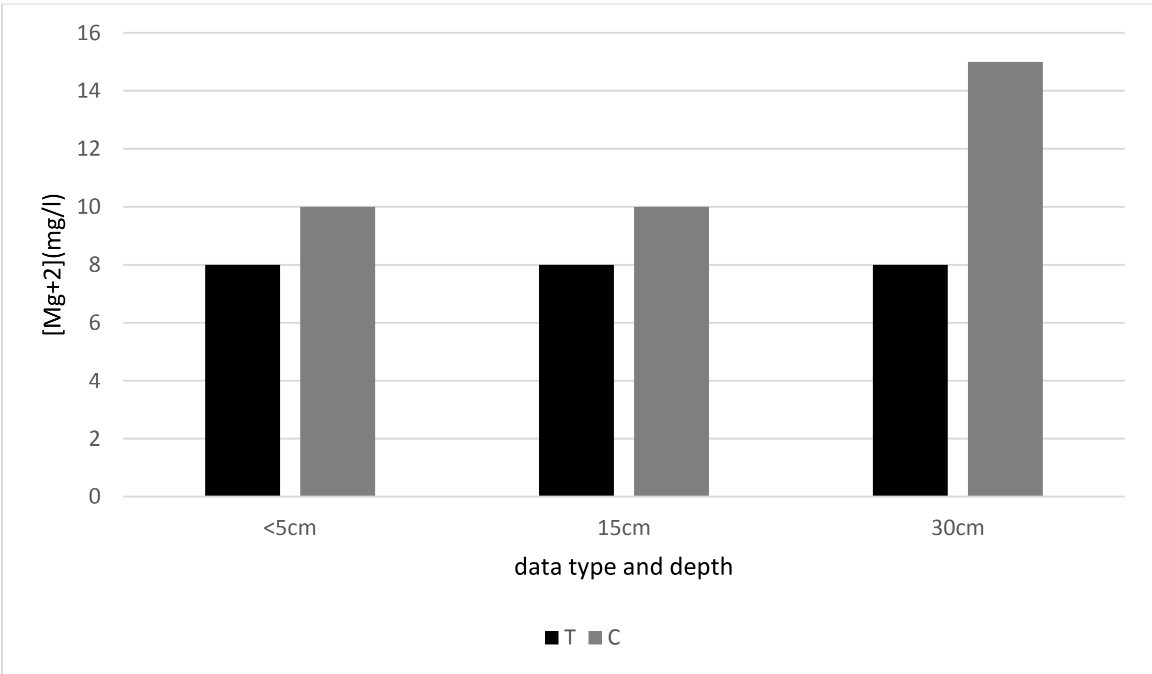


Figure 17: Magnesium ions concentrations in soil for both treated and controlled unit at different depths

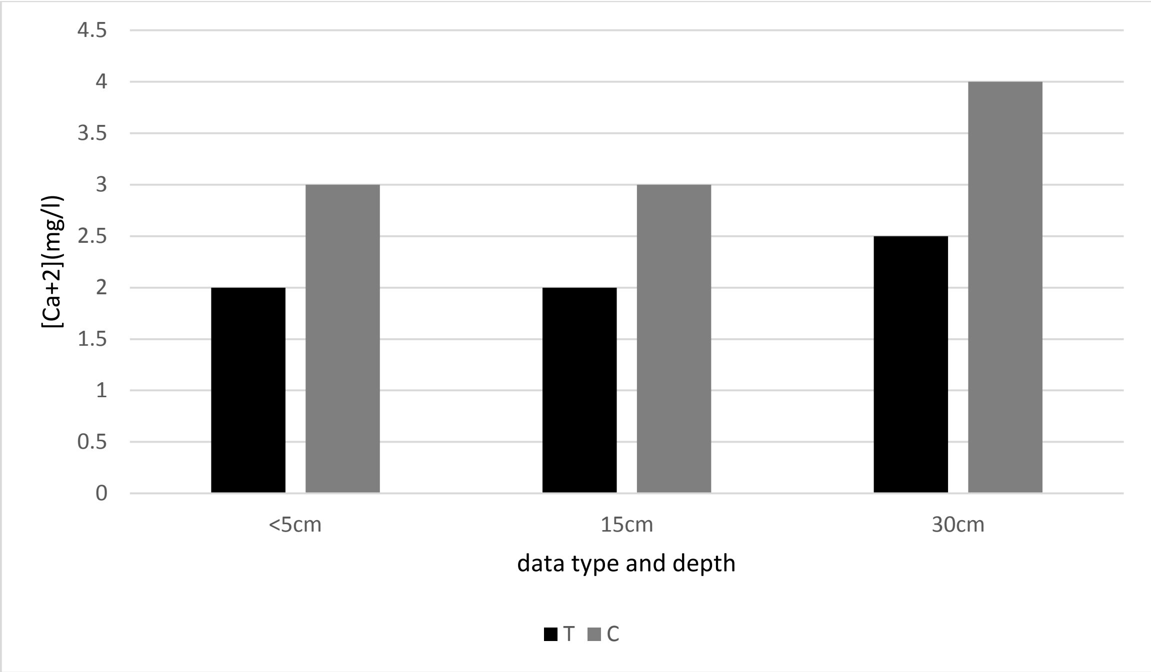


Figure18: Calcium ions concentrations in soil for both treated and controlled unit at different depths

Table 20 represents the results of EC, concentrations for chloride and sodium ions for soil samples collected at different depths. Figure 19 represents the EC for these samples in both treated and controlled units.

Figures 20 and 21 represents plots of Cl- and Na+ ions concentration vs depth, respectively, for both treated and controlled units.

Based on these results, it can be seen that the ions concentration in treated units are lower than those for controlled units. This explains the decrease in the ECs for soil samples irrigated with MW compared with those irrigated with controlled water. This is because of the ability of MW water to dissolve additional minerals through its pathway.

Table20:EC and concentration of chloride and Sodium in soil sample for different depth

Sample depth	Sample type	ECµS/cm	Cl^-[mg/L]	Na^+[mg/L]
<5cm	T	150	35.5	28
	C	160	71	25
10cm	T	157	35.5	28.7
	C	163	71	25.5
20cm	T	104	35.5	19.9
	C	191	35.5	28.8
30cm	T	114	35.5	19.9
	C	247	71	34.3
40cm	T	106	35.5	20.5
	C	208	35.5	31.1
50cm	T	120	35.5	25.4
	C	200	35.5	28.5
60cm	T	104	35.5	23.5
	C	201	35.5	28
70cm	T	122	35.5	29.4
	C	178	35.5	34.2

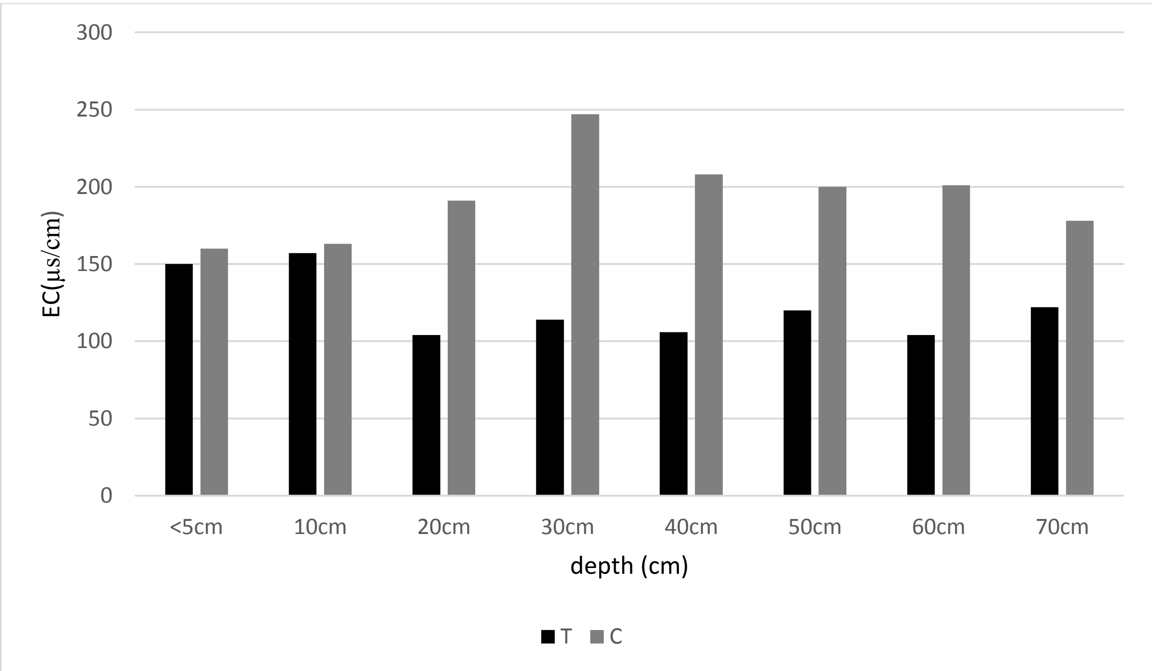


figure19:EC for soil samples in both treated and controlled unit with difference depth

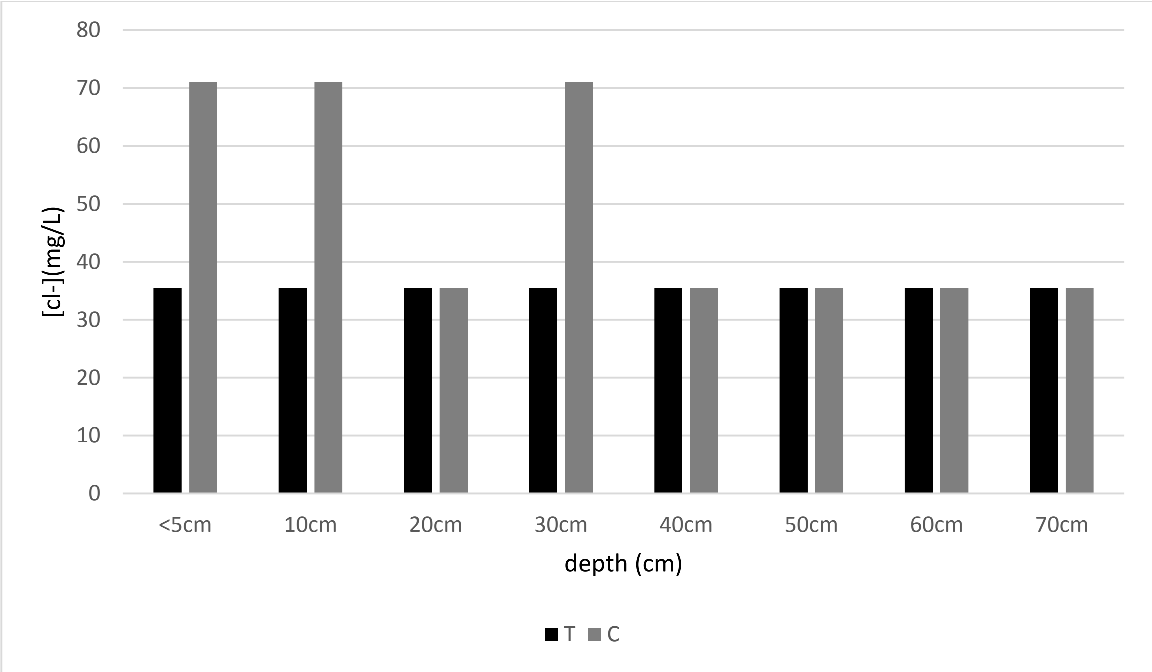


Figure20: Chloride ions concentrations for soil samples in both treated and controlled unit at difference depth

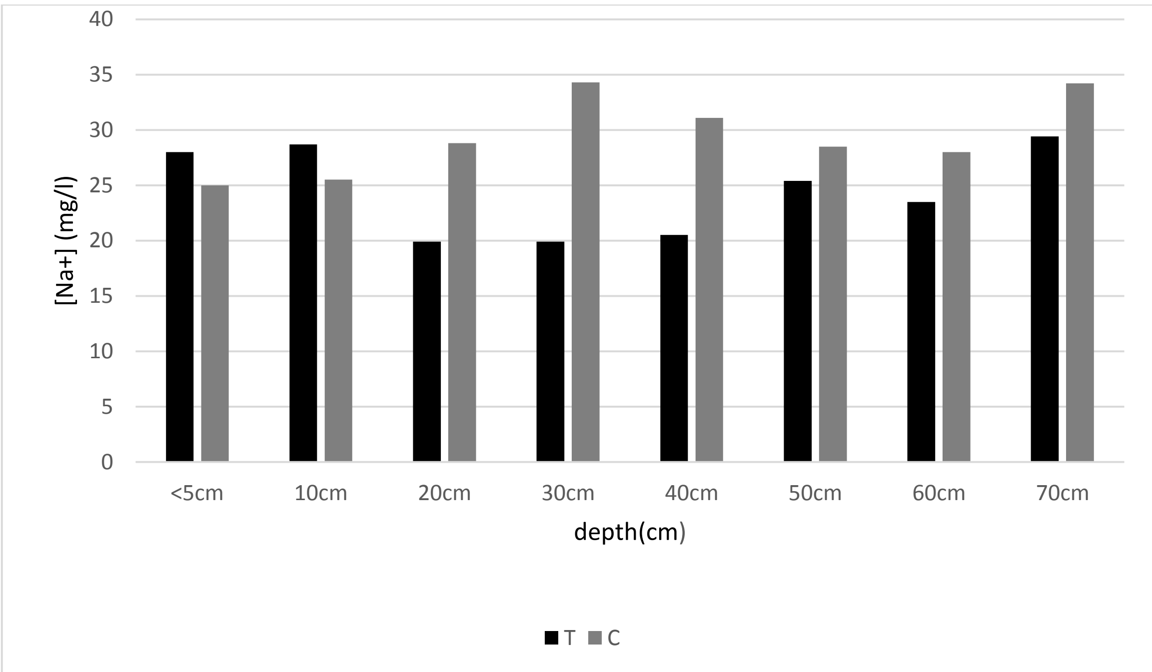


Figure21: Sodium ions concentrations for soil samples in both treated and controlled unit at difference depths

Chapter Six

Conclusion and Recommendations

6.1 Conclusion

Oregano and Tarragon are traditional well known medical herbs in our country. These herbs were chosen to study the effect of new technology of magnetic water treatment on these plants.

It was observed that there were on obvious increase in fresh yield, water productivity, water and chlorophyll contents and fresh root biomass for both herbs. The influence of magnetized water on Tarragon was less than that for Oregano which indicates that Tarragon is more resistant to salinity than Oregano.

Since treated samples contain higher water contents than controlled samples, it's advisable to sell fresh herbs rather than dry one.

There was also, a decrease in the number of blocked dripper for treated units compared to the controlled units.

The salinity of soil which was irrigated by magnetized water was also decreased.

6.2 Recommendations

- More research should be done on other plants to see the influence of MWT on it.
- Corporation with the ministry of Agriculture to support such projects.
- This experience can be shared with large farms in order to improve their products.

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Appendices

Appendix 1 : Oregano sample description

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Treatment	25	50.0	50.0	50.0
	Control	25	50.0	50.0	100.0
	Total	50	100.0	100.0	

Appendix 2: Oregano sample distribution among line.

		Intervention			
		Treatment		Control	
		Count	Column N %	Count	Column N %
LINE	Line One	5	20.0%	5	20.0%
	Line Two	6	24.0%	7	28.0%
	Line Three	8	32.0%	7	28.0%
	Line Four	6	24.0%	6	24.0%

Appendix 3: The effects on Height, number of major branches and number of minor branches of oregano in the control and treatment groups in the following tables:

		Intervention			
		Treatment		Control	
		Mean	Std	Mean	Std
6-11	H1	8.44	2.2	9.32	2.4
	major B1	2.20	1.5	2.32	1.8
	Minor B1	1.04	3.3	3.12	4.8
15-11	H2	13.36	3.2	14.88	4.3
	major B2	4.96	2.5	3.56	2.7
	Minor B2	24.32	13.2	24	9.8
20-11	H3	18.20	3.7	18.60	5.2
	major B3	4.32	2.3	2.56	1.8
	Minor B3	40.08	21.3	30.36	16.7
28-11	H4	23.80	4.3	26.08	5.9
	major B4	4.56	2.4	2.56	1.7
	Minor B4	66.72	37.7	56.72	29.7
5-12	H5	28.32	4.3	30.80	6.6
	major B5	5.36	2.6	2.92	2.4
	Minor B5	123.92	56.2	106.4	57.1
12-12	H6	35.00	5.3	35.68	7.2
	major B6	5.44	2.6	3.24	2.5
	Minor B6	230.64	92.4	197.76	94.3

Appendix 4: Treatment and control groups according to the greenhouse lines

		Line One				Line Two				Line Three				Line Four			
		treatment		Control		treatment		control		treatment		Control		treatment		Control	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
6-11	H1	10.80	2.3	8.60	2.6	8.00	1.4	8.71	2.1	7.38	2.1	8.57	1.3	8.33	2.0	11.50	2.7
	major B1	2.00	1.2	3.80	3.0	2.00	1.3	2.00	1.4	2.75	2.0	1.71	1.1	1.83	1.2	2.17	1.0
	Minor B1	3.60	7.0	0.00	0.0	.33	.8	2.14	3.8	.75	1.5	1.00	2.6	.00	.0	9.33	4.8
15-11	H2	16.80	4.0	12.60	4.9	12.50	2.3	13.57	3.4	11.50	1.6	14.43	2.5	13.83	2.9	18.83	4.6
	major B2	4.00	1.9	5.00	4.2	6.00	1.9	3.00	2.8	5.38	3.6	4.00	1.8	4.17	1.6	2.50	1.4
	Minor B2	23.00	9.7	28.60	18.5	18.50	15.1	22.14	17.8	28.50	16.7	20.29	2.7	25.67	8.7	26.67	7.4
20-11	H3	22.00	5.0	16.00	5.8	18.33	3.1	16.86	3.8	15.38	1.3	18.00	3.0	18.67	2.7	23.50	6.0
	major B3	4.00	1.9	3.80	3.0	5.00	2.0	2.00	1.2	4.75	3.1	2.57	1.5	3.33	1.5	2.17	1.0
	Minor B3	56.00	31.9	35.20	25.4	37.67	12.2	27.71	10.3	37.50	21.9	27.57	10.1	32.67	14.4	32.67	9.5
28-11	H4	28.60	5.2	22.60	7.5	23.17	3.2	24.14	3.8	20.63	2.7	26.00	4.8	24.67	2.7	31.33	5.4
	major B4	4.00	1.9	4.00	2.9	4.83	1.7	2.29	1.1	5.38	3.3	2.00	1.2	3.67	1.8	2.33	1.2
	Minor B4	89.60	54.7	65.60	49.50	57.00	19.0	44.86	19.5	67.75	43.6	51.43	28.0	56.00	25.0	69.33	19.3
5-12	H5	32.40	6.6	28.00	8.7	28.00	3.5	28.43	4.5	26.00	2.6	30.29	5.7	28.33	2.4	36.50	5.5
	major B5	5.20	2.5	5.20	4.1	5.67	1.5	2.29	1.1	6.13	3.6	2.14	1.2	4.17	1.8	2.67	1.9
	Minor B5	166.40	70.2	111.20	86.5	96.00	32.8	96.86	44.1	120.25	60.8	90.86	42.0	121.33	46.8	131.67	62.8
12-	H6	39.40	7.6	32.80	9.6	33.33	5.1	33.00	5.8	33.88	4.8	35.00	6.0	34.50	2.1	42.00	5.1

	major B6	**5.20**	**2.5**	**5.20**	**4.1**	**5.83**	**1.7**	**2.86**	**2.0**	**6.25**	**3.5**	**2.71**	**1.5**	**4.17**	**1.8**	**2.67**	**1.9**
	Minor B6	**285.20**	**102.6**	**184.80**	**119.5**	**178.00**	**75.3**	**200.57**	**83.3**	**213.25**	**100.5**	**164.00**	**79.2**	**261.00**	**69.5**	**244.67**	**104.7**

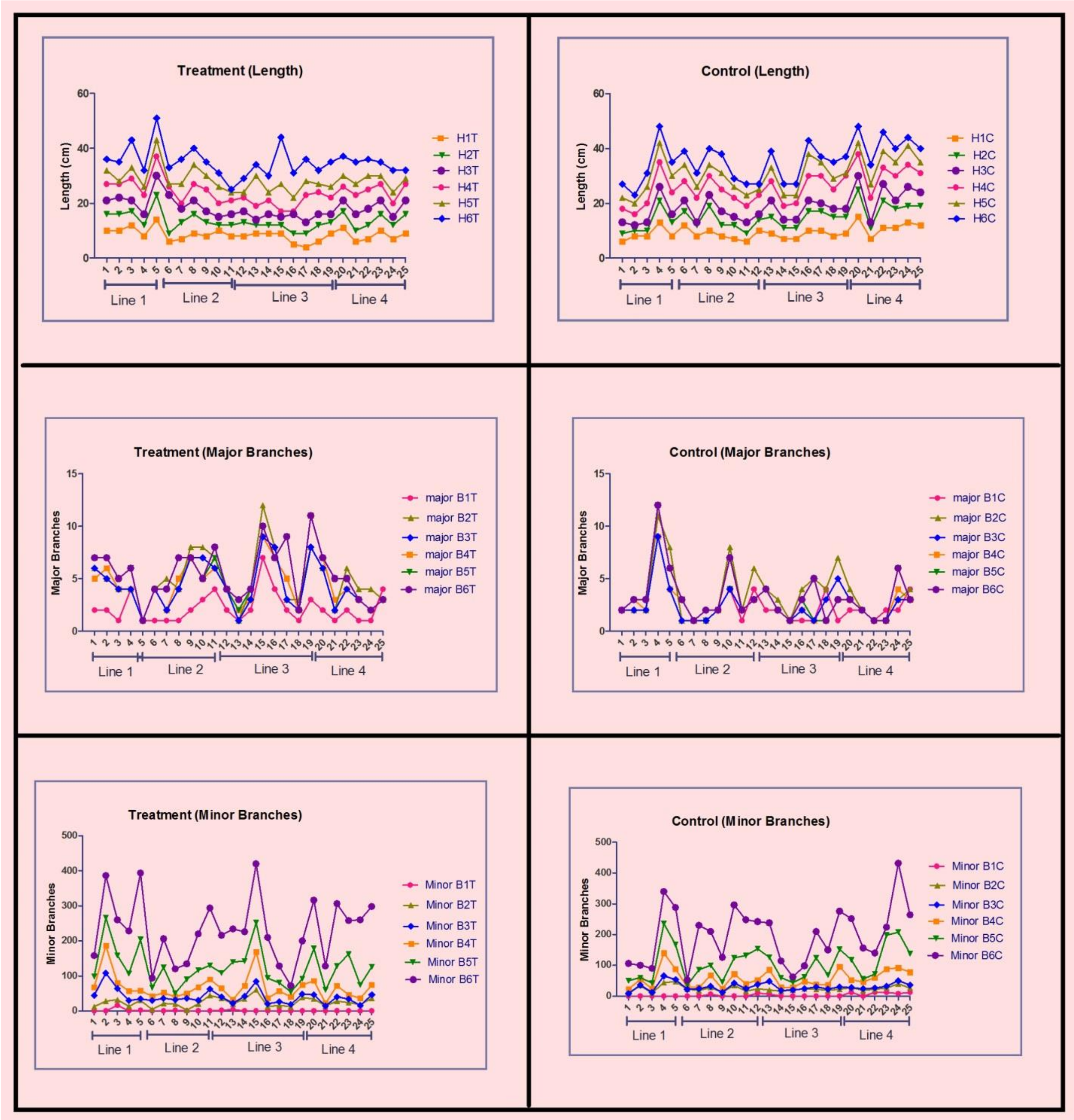
Appendix 5: Summary of independent t test for oregano variables

Variable	test value	Significant value	significant or not
H1	Independent t-test (t=-1.354)	0.182	not significant
H2	Mann-Whitney (U=256.5)	0.273	not significant
H3	Mann-Whitney (U=305)	0.883	not significant
H4	Independent t-test (t=-1.551)	0.128	not significant
H5	Mann-Whitney (U=249)	0.216	not significant
H6	Mann-Whitney (U=286.5)	0.613	not significant
Major B1	Mann-Whitney (U=305)	0.878	not significant
Major B2	Mann-Whitney (U=200)	0.027	significant (treatment>control)
Major B3	Mann-Whitney (U=159)	0.002	significant (treatment>control)
Major B4	Mann-Whitney (U=136)	0.001	significant (treatment>control
Major B5	Mann-Whitney (U=126)	0.000	significant (treatment>control
Major B6	Mann-Whitney (U=142.5)	0.001	significant (treatment>control
Minor B1	Mann-Whitney (U=263)	0.213	not significant
Minor B2	Mann-Whitney (U=309.5)	0.953	not significant
Minor B3	Mann-Whitney (U=233)	0.082	not significant
Minor B4	Mann-Whitney (U=262.5)	0.332	not significant
Minor B5	Mann-Whitney (U=250)	0.225	not significant
Minor B6	Mann-Whitney (U=255)	0.264	not significant

Appendix 6: Summary of related sample t test for oregano variable**s**

Variable	test value	Significant value	significant or not
H1	Paired Samples Test (t=-1.254)	0.222	not significant
H2	Wilcoxon Test (Z=-1.463)	0.143	not significant
H3	Wilcoxon Test (Z=-0.486)	0.627	not significant
H4	Paired Samples Test (t=-1.5)	0.147	not significant
H5	Wilcoxon Test (Z=-1.428)	0.153	not significant
H6	Wilcoxon Test (Z=-0.655)	0.513	not significant
Major B1	Wilcoxon Test (Z=-0.481)	0.630	not significant
Major B2	Wilcoxon Test (Z=-1.866)	0.062	not significant
Major B3	Wilcoxon Test (Z=-2.353)	0.019	significant (treatment>control)
Major B4	Wilcoxon Test (Z=-2.617)	0.009	significant (treatment>control
Major B5	Wilcoxon Test (Z=-2.457)	0.014	significant (treatment>control
Major B6	Wilcoxon Test (Z=-2.295)	0.022	significant (treatment>control
Minor B1	Wilcoxon Test (Z=-1.437)	0.151	not significant
Minor B2	Wilcoxon Test (Z=-0.286)	0.775	not significant
Minor B3	Wilcoxon Test (Z=-1.522)	0.128	not significant
Minor B4	Wilcoxon Test (Z=-0.672)	0.502	not significant
Minor B5	Wilcoxon Test (Z=-1.229)	0.219	not significant
Minor B6	Wilcoxon Test (Z=-1.308)	0.191	not significant

Appendix 7: comparison between treatment and control samples of Oregano



Appendix 8 : Tarragon sample description

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	treatment	25	50.0	50.0	50.0
	control	25	50.0	50.0	100.0
	Total	50	100.0	100.0	

Appendix 9: Tarragon sample distribution among line.

		Intervention			
		Treatment		Control	
		Count	Column N %	Count	Column N %
LINE	Line One	5	20.0%	5	20.0%
	Line Two	7	28.0%	7	28.0%
	Line Three	7	28.0%	7	28.0%
	Line Four	6	24.0%	6	24.0%

A**ppendix10: The** effects on Height, number of major branches and number of minor branches of the Tarragon in the control and treatment groups for Tarragon.

		Intervention			
		treatment		**Control**	
		Mean	**Std**	**Mean**	**Std**
22-10	**H1**	**18.00**	**3.7**	**20.24**	**3.3**
	major B1	**2.44**	**.7**	**2.68**	**1.0**
	Minor B1	**7.20**	**4.7**	**6.72**	**5.3**
31-10	**H2**	**23.48**	**5.2**	**25.52**	**3.8**
	major B2	**2.84**	**.7**	**2.92**	**1.2**
	Minor B2	**18.76**	**8.2**	**21.12**	**11.1**
6-11	**H3**	**29.04**	**5.2**	**31.38**	**4.5**
	major B3	**3.36**	**1.2**	**3.76**	**1.6**
	Minor B3	**53.48**	**23.0**	**48.00**	**21.8**
15-11	**H4**	**37.92**	**6.6**	**38.61**	**5.7**
	major B4	**3.64**	**1.3**	**4.00**	**1.6**
	Minor B4	**85.92**	**29.8**	**86.71**	**24.9**
20-11	**H5**	**41.33**	**6.8**	**42.83**	**6.1**
	major B5	**3.76**	**1.3**	**4.20**	**1.6**
	Minor B5	**115.13**	**37.5**	**118.25**	**31.9**
26-11	**H6**	**45.17**	**7.2**	**46.56**	**6.7**
	major B6	**3.68**	**1.4**	**4.24**	**1.5**
	Minor B6	**126.96**	**48.6**	**149.13**	**45.5**

Appendix 11: Treatment and control groups according to the greenhouse lines for Tarragon

		Line One				Line Two				Line Three				Line Four			
		treatment		Control		treatment		control		treatment		Control		treatment		Control	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
22-10	H1	17.40	1.1	20.40	1.7	16.29	1.0	17.86	4.1	19.86	3.9	20.71	3.1	18.33	5.9	22.33	2.1
	major B1	2.40	.5	2.40	.9	2.29	.8	3.29	1.1	2.57	.5	2.71	1.1	2.50	.8	2.17	.8
	Minor B1	5.20	5.6	10.00	6.2	10.00	5.6	10.71	4.0	4.86	2.3	3.00	2.2	8.33	3.4	3.67	4.1
31-10	H2	23.00	4.2	25.00	3.2	20.86	1.9	24.71	4.9	23.29	5.0	25.14	4.3	27.17	7.4	27.33	2.0
	major B2	3.00	.7	2.60	.9	2.71	.8	3.71	1.1	3.00	.8	2.86	1.3	2.67	.8	2.33	1.0
	Minor B2	21.40	11.0	19.00	5.1	18.29	7.9	28.00	13.8	21.43	9.0	21.71	7.1	14.00	2.8	14.17	12.3
6-11	H3	27.60	5.2	30.20	1.8	27.43	3.3	31.00	7.6	28.71	5.0	31.14	3.7	32.50	6.6	33.00	3.4
	major B3	3.20	.8	3.20	1.3	3.14	.7	5.29	2.0	3.57	1.5	3.43	.8	3.50	1.8	2.83	1.0
	Minor B3	49.40	25.9	55.80	20.7	51.00	26.6	55.14	32.9	59.86	25.0	40.43	7.3	52.33	18.1	42.00	18.1
15-11	H4	35.60	5.7	36.00	1.6	36.71	7.5	36.33	7.0	39.00	5.5	39.71	6.6	40.17	7.9	42.40	3.6
	major B4	3.20	.8	3.40	1.3	3.29	.8	5.43	1.9	4.00	1.6	3.71	1.3	4.00	1.7	3.17	.8
	Minor B4	80.00	24.6	88.20	21.6	89.14	25.9	96.50	12.6	96.00	40.3	65.43	16.0	77.00	29.9	100.50	32.3
20-11	H5	41.00	5.4	42.00	3.7	39.43	7.2	41.50	9.9	41.00	4.7	42.71	5.9	44.17	9.5	45.00	3.3
	major B5	3.40	.5	3.60	1.5	3.57	1.3	5.43	1.9	4.00	1.6	3.71	1.3	4.00	1.7	3.83	.8
	Minor B5	111.50	29.5	110.00	21.6	105.00	36.9	113.33	25.9	135.00	45.9	106.43	33.0	109.50	35.6	143.83	35.3
26-11	H6	44.40	4.2	46.00	4.2	41.14	7.3	46.71	8.9	46.83	6.2	45.29	8.4	48.83	8.8	48.33	4.2
	major B6	3.00	.7	3.60	1.5	3.57	1.3	5.57	1.7	4.00	1.6	3.71	1.3	4.00	1.7	3.83	.8
	Minor B6	96.20	56.1	117.20	17.5	107.86	33.1	144.50	46.0	166.67	35.5	134.43	31.1	135.17	48.5	197.50	42.9

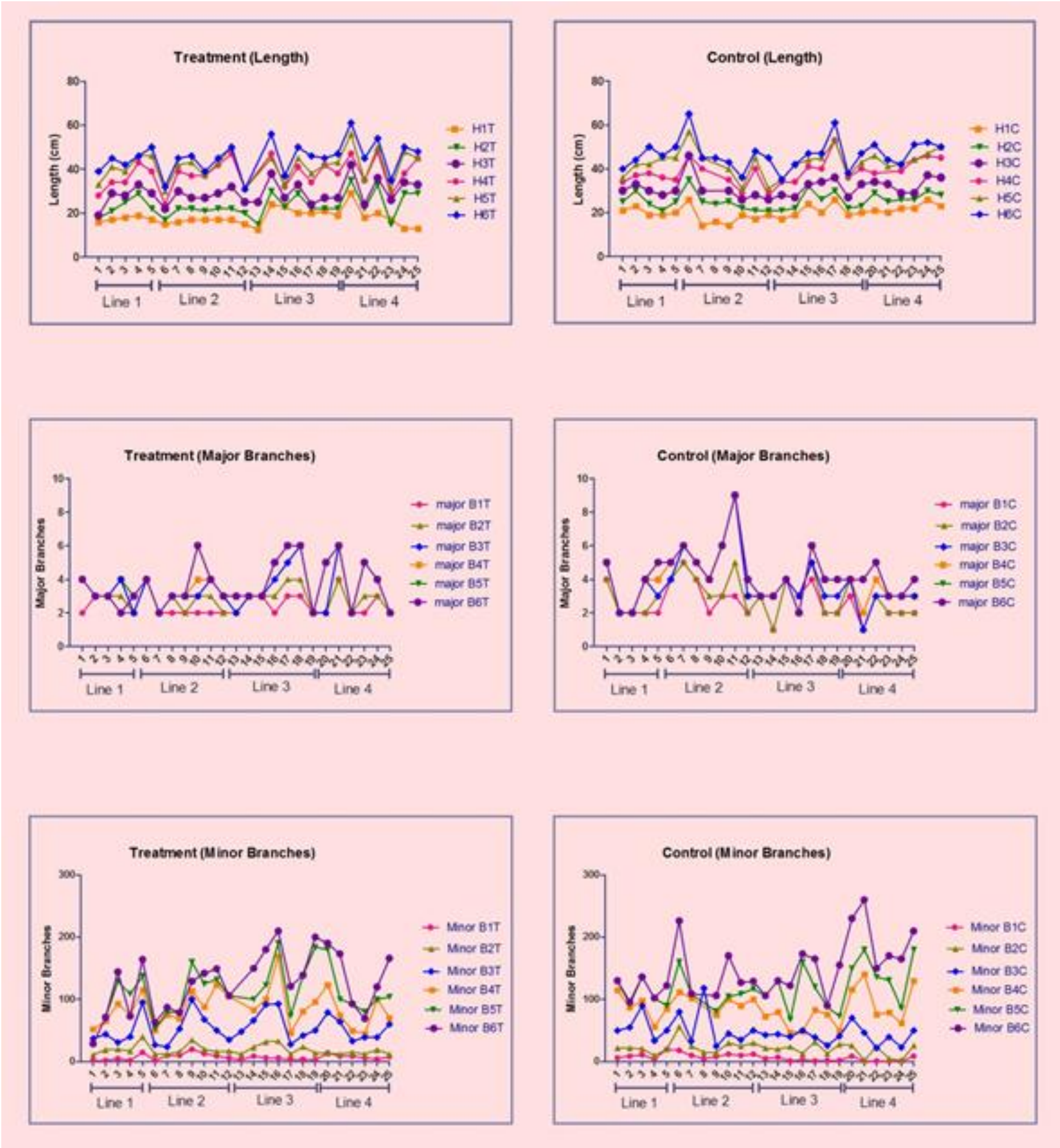
Appendix 12: summary of independent t test for Tarragon variables

Variable	test value	Significant value	significant or not
H1	Independent t-test (t=-2.266)	0.028	significant (control>treatment)
H2	Mann-Whitney (U=221.5)	0.075	not significant
H3	Mann-Whitney (U=205)	0.056	not significant
H4	Independent t-test (t=-0.385)	0.702	not significant
H5	Independent t-test (t=-0.808)	0.424	not significant
H6	Independent t-test (t=-0.701)	0.487	not significant
Major B1	Mann-Whitney (U=275)	0.422	not significant
Major B2	Mann-Whitney (U=310)	0.959	not significant
Major B3	Mann-Whitney (U=268)	0.370	not significant
Major B4	Mann-Whitney (U=276)	0.467	not significant
Major B5	Mann-Whitney (U=261)	0.306	not significant
Major B6	Mann-Whitney (U=244)	0.174	not significant
Minor B1	Mann-Whitney (U=279.5)	0.520	not significant
Minor B2	Mann-Whitney (U=241.5)	0.167	not significant
Minor B3	Mann-Whitney (U=273.5)	0.448	not significant
Minor B4	Independent t-test (t=-.100)	0.921	not significant
Minor B5	Independent t-test (t=-0.308)	0.760	not significant
Minor B6	Mann-Whitney (U=224)	0.268	not significant

Appendix 13: summary of related sample test for Tarragon variables.

Variable	test value	Significant value	significant or not
H1	Paired Samples Test (t=-2.322)	0.029	significant (control>treatment)
H2	Wilcoxon Test (Z=-1.617)	0.106	not significant
H3	Wilcoxon Test (Z=-1.367)	0.172	not significant
H4	Paired Samples Test (t=-0.353)	0.728	not significant
H5	Paired Samples Test (t=-1.067)	0.298	not significant
H6	Paired Samples Test (t=-0.889)	0.383	not significant
Major B1	Wilcoxon Test (Z=-0.988)	0.323	not significant
Major B2	Wilcoxon Test (Z=-0.294)	0.769	not significant
Major B3	Wilcoxon Test (Z=-1.111)	0.266	not significant
Major B4	Wilcoxon Test (Z=-0.891)	0.373	not significant
Major B5	Wilcoxon Test (Z=-1.000)	0.317	not significant
Major B6	Wilcoxon Test (Z=-1.289)	0.197	not significant
Minor B1	Wilcoxon Test (Z=-0.659)	0.510	not significant
Minor B2	Wilcoxon Test (Z=-0.741)	0.459	not significant
Minor B3	Wilcoxon Test (Z=-1.238)	0.216	not significant
Minor B4	Paired Samples Test (t=-0.069)	0.945	not significant
Minor B5	Paired Samples Test (t=-0.130)	0.898	not significant
Minor B6	Wilcoxon Test (Z=-1.331)	0.183	not significant

Appendix 14: comparison between treatment and control samples of Tarragon



Appendix 15: photos from site.

Appendix16: Tarragon photos.


Treatment unit


The Compete Project
Using of Magnetized Water Technology in Irrigation
Lower Jordan Valley
Treatment unit
Crop: Tarragon
Area: 300 m²
Date of Agriculture: 21/09/2012
Start Data treatment: 21/09/2012

Appendix 17: Oregano photos.