بسم الله الرحمن الرحيم

EFFECT OF MAGNETIZING WATER AND NITROGEN FERTILIZATION ON GROWTH AND YIELD OF CUCUMBER (*Curcumas sativus L.*) UNDER COOLED PLASTIC HOUSE CONDITIONS.

By

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xDEDICATION

To my late mother and father.

To my pretty wife, loves daughters and son.

To my beloved brothers, sisters and friends.

To those who cultivate the soil.

With best wishes and love for all.

Awad El Kareem

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First of all thanks to Allah, who gave me the health, strength, power and patience to complete this study.

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ABSTRACT

An experiment was conducted at the Horticulture Exports Center, Khartoum State, to study the effect of magnetized irrigation water and different levels of nitrogen fertilization on growth and yield of cucumber (*Cucumis sativus L.*) under cooled plastic house conditions. Soil analysis was done before planting and after harvesting of cucumber. The treatments were magnetized and non- magnetized irrigation water with different levels of nitrogen (0, 10, 20, 30, 40, 50 and 60 g/m^2), which were applied in two doses 21 and 43 days from planting, respectively. Split plot design was used with three replications. Data were collected on rate of germination, plant height, length of internodes, stem diameter, number of leaves per plant, leaf area, length of fruit, number of flowers per plant and number and weight of fruits per m^2. Also, the chemical and physical properties of soil, fruits and water were determined. On the other hand, the plants irrigated by magnetized water gave significantly higher results compared to those irrigated by non-magnetized water for all parameters. Particularly with nitrogen application of 30 and 40 g/m^2.

المستخلص

أجريت التجربة بمركز الصادرات البستانية، ولاية الخرطوم لدراسة أثر الرى بالماء الممغنط وغير الممغنط مع سماد النيتروجين على نمو وإنتاجية محصول الخيار تحت تأثير البيوت البلاستيكية المبردة، أجريت تحاليل للتربة قبل الزراعة وبعد حصاد الخيار. أستخدمت جرعات مختلفة من سماد النيتروجين (٠، ١٠، ٢٠، ٣٠، ٤٠، ٥٠ و٦٠ جرام/م^{٢}) نيتروجين للمتر المربع والتي أضيفت على جرعتين بعد ٢١ و٤٣ يوم، على التوالي من تاريخ الزراعة. أستخدم تصميم القطع المنشقة بثلاثة مكررات. وقد شملت البيانات التى جمعت نسبة الإنبات، طول النبات، طول السلاميات، قطر الساق، عدد الاوراق للنبات، مساحة الورقة، طول الثمرة، عدد الأزهار للنبات، عدد الثمار ووزنها للمتر المربع. وأيضاً تم إجراء التحليل الكيميائى والفيزيائى للتربة والثمار والماء. أظهرت النتائج فروقات معنويه من خلال تأثير المعاملات المختلفة حيث أدت النباتات التى رويت بالماء الممغنط إلى نتائج عالية المعنوية من التى رويت بالماء غير الممغنط خاصة مع جرعة النيتروجين ٣٠ و٤٠ جرام/م^{٢}.

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CHAPTER ONE

INTRODUCTION

Magnetization technology has been used in irrigation to reduce the effect of salt concentration in soil and water. It has been used in Russia and United Arab Emirates (UAE) in agriculture. Water magnetization technology makes the main minerals in the soil easily absorbed by the plants. This technology is important in reducing the effect of salinity in the soil and water especially in protected culture where the cultivated area is small and the irrigation system is under control. The technology is more expensive to use in open areas (Tkatchenko, 1997).

Magnetizing causes physical–chemical changes of natural water parameters, resulting in improvement of filtration and in an increase of dissolving properties. These changes result in an increased ability of soil to get rid of salts and a better assimilation of nutrients and fertilizers in plants during the growing cycle (Tkatchenko, 1999).

Nitrogen is one of the big three plants nutrients; which is used in large amounts. Nitrogen helps plants make lots of leaves and is important in helping plants get their green color (www.pronto.com2007).

Plants need mineral salts and trace minerals from the soil for growth and food production. Minerals and nutrients need to be in a proper balance and in a suitable soil pH to be utilized. Watering plants with magnetized water dissolves more nutrients because it lowers the surface tension of water. This lets more minerals be suspended in the soil water. Hence this buffers the pH and causes more nutrients to pass through the cell walls of roots.

Magnetized water penetrates in the soil faster and deeper, allowing for a deeper and larger root zone. Magnetized water dissolves more nutrients into the root zone to become available and consequently stimulate plant growth. These are the reasons why growth rates increase, (crop yields are higher in a shorter time), and even with much less water, fertilizers and pesticides in most cases. This, results in an increased crop production, an improved quality of agricultural products and savings in labor and money. This is also much better for the environment in many ways, both for land and water and the health of the labors that have to handle toxic chemicals under conventional methods. Customers will benefit due to better nutrition and less chemicals (Been, 2007).

The benefits vastly outweigh the investment cost, which will be returned year by year. In short, the agronomic advantages of using magnetized water for irrigating crops will make them look more green, strong and healthy. Also the growing cycle decreases by 15-20 days and harvest being 15-20 days earlier. Crop production increases by 15-20%. Plant diseases drastically decrease, taste of agricultural products improves and approximately 30% less irrigation water is used. Therefore, 30% less energy is used for pumping water. Sea water can be used for watering (from 6 to 8 thousand PPM) and for some cultures. By magnetizing seeds before sowing and by irrigating them with magnetized water, the need for nutrients decreases by a minimum of 30%. Salty soil desalination takes place, hence increasing crop production year after year.

In the case of plants magnetizing irrigation water will cause many advantages, including increase of germination rate, development of root and shoot systems, development of first flowers, development of first fruits, number of fruits, difference in quantity and quality of harvest. In soil the benefits include, reduced amount of salts in different depths of the soil (from 1 to 1.5 m) before irrigation process, leaching away of salts while irrigating soil with magnetized water and washing of various anions from the soil (Ben, 2007)

Drip irrigation is one of the most recent irrigation systems in Sudan. It is useful for compensating the actual evapotranspiration of the plant plus satisfying water needs of its growth. This system is well and quickly disseminating in dry areas (Michael, 1978).

Cucumber (*Cucumis sativus L).* is one of the oldest cultivated vegetables in the world (Salunkhe and Desai, 1984), and in Sudan it has become important to most families especially in Khartoum State, because of rich in vitamins and minerals.

The use of cooled plastic houses or protected systems of production is expected to reduce the effects of the hot climate (dead season) and help increase the yield quantitatively and qualitatively, on the other hand magnetization of irrigation water is envisaged to result in improvement of yield.

The study is conducted with a view to investigating cucumber (*Cucumis sativus L.*) growth and yield at different levels of nitrogen fertilization while magnetizing irrigation water applied by the drip irrigation system under cooled plastic house conditions.

CHAPTER TWO
LITERATURE REVIEW

2.1. The importance of water to plants

Water is perhaps the most important factor influencing plant growth (Townsend.1986). It is the single most important factor limiting crop yield. Thorough knowledge of crop water relation is of paramount importance since it affects plant growth and yield quantitatively and qualitatively. Many approaches were made to study the crop water relation by the measurement of consumptive use. Different agricultural practices were adopted to increase the crop water use efficiency with the aim of giving the least amount of water to obtain the maximum crop yield. Water may reach up to 95% in the case with leafy plants. It is worth mentioning that, water is the earth's most abundant compound and yet on a world wide scale there is a deficit. (Abdel Hafeez, 1984).

2.1.1. The role of water in plants

Water plays paramount roles for plants, which may be summarized as follows:

a- Water is a major constituent of the essential process of photosynthesis.

b- It acts as a solvent for all plant nutrients.

c- It is a translocation agent of food materials to all plant parts.

d- It controls both plant and soil temperature at a level that is suitable for plant growth and development.

e- Water is a leaching agent.

f- It keeps the plant cells turgid.

g- Water helps penetration of plant roots in the soil.

h- Also it helps in conducting some agricultural practices e.g. ploughing, ridging, etc.

i- Water is responsible for the activity of the soil micro and macro-organisms.

Generally, the daily use of water by man is now considered as a yard stick for the level of civilization and progress of any nation. In 1970 the domestic water consumption in Britain amounted to one hundred liters per person per day. Water besides irrigation can be used for domestic supply, affluent disposal, fishing, navigation, power, industrial water supply or recreation (Abdel Hafeez, 1984). The following figures may be of interest.

i- One hectare of rice needs 23770 m^3 of water/season.

ii- One hectare of vegetables needs 13560 m^3 of water/season.

iii- One hectare of cotton needs 11130 m^3 of water/season.

2.1.2. Effects of Excess Moisture

1- Loss of nutrients by leaching especially nitrate.

2- Insufficient soil aeration.

3- Delayed maturity.

4- Wilting and poor growth.

5- Reduction in yield.

2.1.3. Effects of water Deficit

1- Wilting and curtailing of growth.

2- Hastening maturity.

3- Reduction of yield and quality.
4- Harmful salt accumulation.

2.1.4. Effects of Optimal Moisture Condition

Optimal moisture condition varies from one crop to another depending on many factors. But if it is maintained through out plant growth and development maximum crop yield would be obtained.

2.1.5. Factors Effecting Crop Water Relations

The relation between the crop and water is a complex one since it is influenced by a large number of continuously changing factors. Among these are the soils, the plant and the climate.

2.1.5.1. Soil Factors

This includes all physical, chemical and biological properties of the soil. Generally any soil factor that influences plant growth quantitatively and qualitatively will affect this relationship.

2.1.5.2. Plant Factors

Plants are grouped according to their water needs into the following:

a) Hydrophytes
b) Mesophytes
c) Xerophytes

Many adaptations were made by each group to match its water condition.

2.1.5.3. Climatic Factors

Climatic factors affect the crop water relation directly through their effects on the plant aerial parts and indirectly through the effects on subterranean ones.

2.1.6. Measurements of Consumptive Use (evapotranspiration)

Many approaches were introduced to measure, directly or indirectly, cost and management varies from one approach to the other. The different approaches were supposed to answer the two basic questions of when to irrigate and how much water to apply to the crops to obtain the maximum yield.

2.1.7. Improving Crop Water Use Efficiency

The determination of when to irrigate and how much water to apply to the crops; is not enough to enable man to obtain maximum yields. Approaches to increase crop water use efficiency are now used (Bierhuizen, 1979). These approaches include:

1- Mulching
2- Shading
3- Sheltering
4- Dusting
5- Smoking
6- Wind breaks
7- Choice of proper plant material
8- Antitranspirants

9- Other cultural practices including sowing date, spacing, weeding, type of irrigation system, etc.

Problems associated with crop water have become increasingly important especially in arid and semi-arid regions where water is scarce and evaporation is high. Methods of measurement are to be adopted to enable answering the basic questions of when to irrigate and how much water to apply. Approaches that increase crop water use efficiency are to be adopted to enable giving the minimum amount of water to get the maximum crop yield (Abdel hafeez, 1984).

2.1.8. Watering Plants

Irrigation has four key components.

a- Where to place the water.
b- How much to apply.
c- How fast to apply.
d- How often to apply.

The factors that affect these components include the weather, plants, maturity, plant type and soil type.

Where

For most of plants absorbing roots spread 1.5 to 3 times as wide as the plants canopy and are within one foot of soil surface. It is important to water to entire the root zone each time. Most of the water is absorbed outside the canopy drip line.

How much

Apply enough water to wet soil at least one foot deep in the entire root zone of the plant. Use appointed metal rod to test how deep you have watered by inserting it into the ground soon after you irrigate. The rod will easily slide through the wet soil and became difficult to push when it reachs dry soil.

How fast

Water should be applied only as quickly as it can be absorbed by the soil. Applying water too quick causes erosion, wastes the water and compact the soil surface.

How often

The soil should be allowed to briefly dry out between watering. The plant type, weather, plants maturity, soil type and irrigation method are all key factors determining where to place the water, how much to apply, how quickly to apply and how frequently to apply water.

Weather

Plants in the deserts use 3 to 5 time as much water during the hot, dry summer as they do during the winter. Dry winds also increase plants need for water. On the other hand, plants at higher elevations may not need any supplemental water for many months during winter. In addition, the high humidity and rain during the monsoon season reduce the need for irrigation (Brown, 1998).

Plant maturity

Young should be watered more often than established plants. Initially, water should be applied to the root ball and as the roots grow, the water should be applied out at the drip line and beyond. After establishment, allow a slight drought between watering. The plants will adapt to the stress and become more droughts tolerant.

Plant type

Fast-growing plants need more water than slow-growing plants. Many plants are specifically adapted to arid climates, they may have small leaves, grey foliage, or fuzzy leaves, or other characteristics that enable them survive with less water. These plants need considerably less water than less adapted species with large, dark green leaves.

Soil type

Sandy soils absorb water more quickly and drain more rapidly, therefore, water can be applied slowly and must be applied more frequently. Clay soils absorb water more slowly. Water applied too rapidly to clay soils is wasted and causes erosion as it runs off. If a dike has been built around the root zone of a plant to contain water, then water may be applied quickly without fear of run off.

Irrigation methods

The type of watering methods used will determine how long it will take to sufficiently water plants. Drip irrigation should have enough well-placed emitters to cover the entire root zone. Program the system to run long enough to apply enough water to penetrate two feet deep (Brown, 1998).

2.1.9. Watering greenhouse plants

Watering greenhouse plants aims at watering the soil so that they grow well. How to water, when to water, and various other things such as humidity and moisture will come in to play when the plants start rising. For a successful growth of vegetables under greenhouse conditions, light is one of the most important factors, but watering is just as important as the plants start to take off and produce.

Plants in greenhouse have a limited space on which they can grow and get moisture from the soil hence it is important to learn when a soil is dry and when it is still moist. Plants in greenhouse that are too dry will often get sick and die. The plant has time to absorb water from the soil as the soil is all wet. When a plant is not established it has very little root system. Watering the soil just a bit, but more often is going to satisfy this stage. The plant is known established when the top growth of the plant is more obvious. During seedling stage the plant requires special care. Another important fact about watering the plant is that it uses water that is pure. For example, if there are high amount of salts, calcium, and magnesium they can often harm the plant. If the plants have spots or turning brown, and if the leaves are falling off and can not find any other source of the damage, it could very well be from water deficiency (*http:// resources greenhouse kit.com,* 2007).

2.2. Water Magnetization.

2.2.1. The magnetic process

The process is that, the magnetic field changes the charge in the dissociating salt molecule, splitting the salt molecule into its sodium and chloride components. This resulted in reduced the electrical conductivity and Total Dissolved Solids (TDS). This process is completed in the soil, also after magnetic treatment there will be a reduction in the electrical conductivity of the water. The degree of reduction will depend on how high the salt level in the water. One sample of water with an ECe of 3520 us/ cm and TDS of 1752 mg/ l, showed an ECe and TDS reduction of 8.5% after being passed through a magnetizing device (deltawater.com. 2006).

2.2.2. How to magnetize water

When water is keep in contact with a magnet for a certain period, magnetism passes into it, and brings about changes mentioned above in its properties. Water can be brought in contact with a magnet in the following way, a magnet may be kept suspended over empty pot, water is poured on the magnet in a thin stream, which flow down and is collected in the pot under it. This method follows nature as in a stream, which happens to flow over a magnetic rock, boulder or stone and get magnetized. In Russia this method is being mechanically exploited in order to magnetize large quantities of water. Russians use high-powered electromagnets for this purpose. But this method has two drawbacks. Remaining continuously under water the magnet could get rusted and then rust would get into water. The other more serious drawback is that water remains in contact with magnet only for a few seconds and it is not likely to get suitably magnetized unless the magnet used is exceptionally powerful. Moreover, magnetization under this process will remain statically of one degree only and it will not be possible to achieve different degrees of magnetization. As regards to the degree of magnetization it depends on three things.

1. The quantity of liquid put on the magnet.
2. The power of the magnet used for the purpose.
3. The duration of the contact of the liquid container with the magnet.

These three factors will naturally determine the degree of magnetization. (Bellokossy, 2000**).**

2.2.3. The miracle of magnetized water

Magnetized water, with the magnet transforms simple water into a miracle liquid with the properties like temperature; density, surface tension, viscosity and conductivity are revolutionized. Water treated with magnetic force succeeded in enhancing the growth rate of agricultural produce by 50%. These miracles in the agricultural fields drew the attention of scientists a few decades back to the therapeutic properties of magnetized water (Bellokossy, 2000).

2.2.4. Water magnetization in Agriculture

Magnetically treated irrigation water has increased the yield of wheat 12.7-33%. This could be attributed to the followings (Helal, 1999).

1. A shorter vegetative period is needed.
2. Reduction of seeds required for sowing.

3. An increase in net yield by 25- 40%
4. A drop in mortality rate by 60- 70% in fruits.
5. A 30% saving of irrigation water.
6. Acceleration of soil desalination by 2- 3 times.
7. Greener and healthier plants were produced.
8. Controlling pH
9. When water is magnetized, the surface tension is reduced and helping the plant cell absorption.

2.2.5. Advantages of magnetized water treatment

1- The change in the water molecules reduces the surface tension of the water hence allowing faster wetting and penetration of water into the root zone.

2- The salt molecules made up of sodium and chloride, these elements are changed to more harmless compounds.

3- Irrigation with magnetized water does not affect plant foliage, allow plants to absorb nutrient more easily from the soil, reduced plant sensitivity to toxic materials and hasten maturity.

4- The changes in water molecules, (as described in point one) result in a leaching action that will prevent salt built up in the root zone and assist in leaching and reducing soil salinity.

5- Vegetable growers have had a lot of success with magnetized water, where much of the bore water is saline resulting in leaf burn, yellowing, increased salt levels in the soil and poor crop performance. Treating the water with magnetic water conditioner has prevented these problems from occurring (deltawater.com 2006).

2.2.6. Recent findings

Recent finding raised the question of testing water after magnetic treatment in order to be able to demonstrate the effectiveness of magnetized water treatment to research a working, to get a better understanding of the changes as a result of magnetized treatment. The findings confirmed what seen in the field.

1- The change to the salt molecule is permanent.
2- There is a reduction in electrical conductivity and Total Dissolved solids level of water after treatment.
3- The main change occurs after treatment in the soil. (www.deltawater.com 2006).

2.3. The importance of nitrogen to plant

Sixteen elements are known as essential nutrients for plant growth. Nitrogen is the most important single nutrient determining the yield of vegetables and other important crops. Considerable increase of yield always follows application of nitrogenous fertilizers. However, studies of nitrogenous forms showed low recoveries of nitrogen fertilizers and consistently greater efficiency of calcium nitrate than ammonium sulphate (Crowther, 1940). Among several possible explanations for the efficiency of ammonium sulphate was the loss of gaseous ammonia. These findings stimulated to perform some of the earliest laboratory and field experiments concerning ammonia volatilization losses which concluded that ammonia volatilization loss was indeed considerable, and was associated with water loss from the soil (Jewitt, 1942).

Nitrogen is one of the big three plants nutrients. It helps plants make lots of leaves and is important in helping plants get their green color. Plants absorb nitrogen from soil as both NH_4^+ and NO_3^- ions, but because nitrification is so pervasive in agricultural soil's, most of nitrogen taken up as nitrate. Nitrate moves freely toward plant roots as they absorb water. Once in side the plant NO_3^- is reduced to NH_4^+ form and is assimilated to produce more complex compounds. Because plants require very large quantities of nitrogen, an extensive root system is essential to allow unrestricted uptake. Plants with roots restricted by compaction may show signs of nitrogen deficiency even when adequate nitrogen is present in the soil (www.pronto.com. 2007).

Nitrogen is essential for growth and reproduction of all plants; it is a basic constituent of proteins. Several different groups of nitrogen-containing compounds may be found in plants. The amounts of each form depend on plant species, maturity and environmental conditions during growth. Under normal growing conditions plants use nitrogen to form plants proteins. Nitrate reduction occurs both in aerial portions and roots of plants; the relative importance of these two sites of nitrate conversion is considered most important.

Excess nitrate within the plant may result from too little of some other plant nutrients rather than an excess of nitrogen. Nitrogen appears to be normally utilized by plants in the form of nitrate. There is, however, considerable evidence to show that ammonium salts can be utilized directly as nitrogen sources. Within the plant nitrogen forms a characteristic constituent element of proteins, which may constitute up to 20 % or more of the dry weight of a plant, as well as being found in many other organic compounds associated with plant life. The effects of nitrogen on plant growth, as they are empirically observed, are fairly characteristic. Suitable nitrogen compounds tend to increase the bulk of plants, and frequently to increase the bulk of the less valuable part of the plant. Increasing quantities of nitrogen will continue to increase the yield up to a certain a mount and then it will depress both the vegetable growth and yield. The ripening of grain is retarded by too great a proportion of nitrogen in the medium of growth and the liability to disease is considerably enhanced (Brown, 1998).

Nitrogen starvation is characterized by a general yellowing of the leaf and stunted growth .The amounts of nitrogen found in soils vary enormously. Soils rich in organic matter contain up to 1 % or more at the other extreme, infertile sands may contain less than 0.05 %. Normal figures for average and moderately fertile loams are from 0.10 % to 0.30 %. The total amount present, however, is no guide to the amount available for the plant, as the facility with which the nitrogen in its various compounds can be converted into nitrate or some other easily assimilated combination, is the chief factor which determines the usefulness of the nitrogen, (Townsend, 1986).

In greenhouse experiments were 220 kg N/ha (22 g/m^2) as NH_4-NO_3 was applied to *Sudan grass*, only 12.8% of total plant nitrogen came from NH_4-NO_3 and 21.4% came from NO_3-N. Gaseous nitrogen losses amounted to 54% of added ammonium and 25% of added nitrate nitrogen. The low percentage of the nitrogen derived from the fertilizers and the high gaseous nitrogen losses especially from the ammonium form are noteworthy.

Certain physical and chemical soil conditions limit early plant growth and reduce its efficiency to absorb available nitrogen (Ayoub, 1982).

2.4. Irrigation

2.4.1. Definition

Irrigation is the artificial application of water to soil for the purpose of crop production (Michael 1978). In many arid and semi-arid areas of Sudan amount and timing of rainfall are not adequate to meet the moisture requirements of crops and irrigation is essential to raise crops necessary to the need for food and fiber.

2.4.2. Drip irrigation

Drip irrigation is the most efficient method of irrigation, which may reach about 90% or more. For this reason, drip irrigation is the preferred method of irrigation in desert regions and arid lands. It is described as the frequent, slow application of water to soil through mechanical devices called emitters or applicators located at selected points along the water delivery lines. The basic concept of drip irrigation system is to provide near optimal soil moisture content in the root zone of the plant. Delivering frequent application of water in discharge points or line source with a discharge of 2-4 l/hr (Michael, 1978).

2.4.3. Advantages of drip irrigation

1- Trickle systems produce higher ratios of yield per unit area and yield per unit volume of water than typical surface or sprinkler irrigation systems.

2- For perfect drip irrigation system design, about 40% of the irrigation water is saved with an application efficiency of 85% - 95% as compared with other irrigation systems.

3- Labor requirements are reduced and the system can be readily automatic.

4- A major advantage of trickle irrigation systems is that the close balance between applied water and crop evapotranspiration reduces surface runoff and deep penetrates to a minimum.

5- Frequent or daily application of water keeps the salts in the soil water more dilute and leached it out limits of the wet pattern to make the use of saline water more practical (Jensen, 1993).

6- Use of trickle irrigation is practical even in fields that have 5 – 6% slope without erosion.

7- Trickle irrigation needs no leveling, no drainage and no other field operations like ridging.

8- Fertilizers and chemicals can be injected into irrigation water causing an accurate distribution just at the root zone.

9- Bacteria, fungi and other pests and diseases that depend on moist environment are reduced; as the above ground plant parts are normally completely dry.

10- The increase in the use of the system could be justified by rapidly rising cost of water and pumping power.

11- The environment is kept sound by not allowing chemicals (fertilizer, pesticides and herbicides) to run deep and penetrate into the soil to affect ground water.

2.4.4. Disadvantages of drip irrigation

1- The major disadvantage of trickle irrigation system is its high capital or initial cost (Michael, 1978).

2- Clogging of emitters by biological, chemical and physical matters.

3- Frequent application of water leach the salts out to the limit of the wetted pattern, if system stops supplying water, the salts may enter to the root zone of the plant causing wilting or poison the plant.

4- Shallow roots due to the limited wet zone. The field needs frequent irrigation and in the case of trees they are liable to tilt in the windward direction and may be up rooted.

2.5. Cucumber (*Cucumis sativus* L.)

2.5.1. Importance:

Cucumber is generally consumed fresh or pickled. The pickling cultivars produce smaller fruits but all cultivars may be used for both purposes, (Split, 1984). It is a primary source of vitamins and minerals in the human diet, but the caloric value is very low (Chouldhunry, 1976). Cucumbers are low in food value and are found in group 4 on production efficiency. This vegetable is used as an appetizer or mixed with other vegetables for its distinctive flavor and texture.

2.5.2. Botanical description

Cucumber is a day neutral annual climbing or trailing herbaceous plant, with a strongly developed tap root system. The stem is stout simple 4 angled, hairy tendrils. The leaves are triangular or ovate in shape 7-20 cm in length, base deeply cordite, apex acuminate, and petiole 5–15 cm in length. Male and female flowers are on the same plant 3–4 mm in diameter. Under high light intensity the plant tend to produce more male flowers than female ones. This is important because the total yield of the crop is directly related to the number of female flowers. Fruits are pendulous variable in shape and size and fresh pale green in color. Seeds are flat and white 8–10 mm long and approximately each 50 seeds weight 1gm (Tindal, 1983 and Rogg, 2002).

2.6. Cucumber production under green house conditions

2.6.1. Cultivars

There are two major types of cucumbers grown under cooled plastic houses for both home and commercial production. The first and most popular one is the long seedless type often referred to as European, Japanese or English. The second one is the old traditional type that has seeds and white spines. Seedless (parthenocarpic) or all female (gynoecious) cultivars are generally recommended for cooled plastic house production. These types generally produce higher yields and do not require bees for pollination. With these varieties there is no need for pollination (Vandre, 1990). In the cooled plastic house it is the grower's responsibility to transfer pollen. When cucumbers are not properly pollinated the first fruit will be misshapen and poorly developed especially at the blossom end of the fruit. Cucumbers are very sensitive to growing conditions such as the fertilizers, salts, light, air, humidity, temperature, carbon dioxide and moisture. Great fluctuation in any of the growing conditions will result in less fruit being produced and bitter tasting cucumbers (Vandre, 1990).

2.6.2. Climatic conditions

Temperature

Cucumbers are well adapted to warm climates but will grow well at lower temperatures than the melons. The temperature requirements for cucumbers during the day are 22.5° – 23° C and for the night is 21° C until first picking. After picking has started, the nighttime temperature may be reduced to 19° C, but only temporarily for 2 to 3 days to stimulate growth. In general, cooler temperatures are used when light intensities are low, (Rafferty and Boyd, 1997).Research has shown that for cucumber the maximum desirable temperature is 25° C and even short periods at temperatures above 27° C are detrimental to fruit quality and yield. Recommended storage temperature of cucumber ranges between (7 – 10° C) (Culpin, 1982).

Radiation:

Plants absorb about 75 percent of the solar radiation they receive. Some of this energy is used in the process of photosynthesis, but the larger proportion is used in transpiration. The quality of radiant heat received by a greenhouse is related to the base area of the structure. Heat gains and losses may be affected by radiation form or to the external surface of the building. Solar gains may be important when determining the refrigeration or ventilation requirements under summer conditions, while radiation frosts may result in unexpected condensation or additional heating requirements in winter (Culpin, 1982).

Light:

Lower light intensity give rise to more female flowers where as high light intensity causes more male flowers (Tindal, 1983 and Rogg, 2002).

Ventilation:

The main function of a greenhouse ventilation system is to prevent air temperature rising above a desirable level in summer. In addition, it serves to introduce fresh air and carbon dioxide necessary for plant growth and to remove excessive humidity. Transpiration increases relative humidity of greenhouse air and this has to be kept to an acceptable limit by ventilation. Where ventilation is inadequate, greenhouse air temperature may be 13 – 16° C above ambient during summer days. Adequate ventilation can reduce this difference to 3 – 6° C under the most conditions. There are two systems of ventilation the natural ventilation and forced ventilation. Temperature rise it related to ventilation rate when the solar radiation intensity inside is 630 w/m^2 (Culpin, 1982).

Carbon dioxide enrichment:

Air normally contains 0.03 % by volume of carbon dioxide. Experimental work has shown that the concentration in greenhouses can often be lower than this. However, optimum concentration is essential for more rapid growth, greater yield and higher quality of the product. Additional CO_2 may be provided by many ways, including cylinders of the liquefied gas or by burning various fuels inside the house. Burning of liquefied petroleum gasses results in production of CO_2, water vapors and heat. For example, burning 1 kg of gas yields 3 kg of CO_2, about 1.5 kg of water vapor and 13.56 kw of heat. This is a convenient method of supply at those times of the years when the heat supplied is of value. When ventilations are open, it is essential to distribute the CO_2 at low level all over the house, so that excessive amounts are not wasted. For best results, concentration of 1000 to 1500 ppm in a cooled plastic house atmosphere should be maintained. Increases of 20 to 40 percent in yield have been reported for various vegetables, when carbon dioxide levels were increased (Culpin, 1982).

Computer control of greenhouse:

Developments in computer technology have made it possible for the control of the whole greenhouse environment by a centralized system. The use of such a controller leads to better precision in the conditions, and enable the grower to implement complex environmental schedules there by maximizing crop response (Culpin, 1982).

2.7. Cultural requirements (practices)

2.7.1. Land preparation

Most of the roots of cucumber are in the top 18–25 cm of the soil. Therefore, soil preparation should be planned in order to produce good soil tilth to a depth of at least 30 cm. The soil should be worked when moisture is adequate but avoid wet soils. Litter from previous crops could be chopped and worked into the soil by discing prior to ploughing to speed up break down of organic matter (Kelley etal., 2000).

2.7.2. Propagation and planting

Seeds are sown on ridges, mounds or prepared planting beds 50 cm of width, wide between two beds is 60 cm. Spacing of 40 cm between plants. Plants can also be raised in containers and planted when 14 – 21 days old. Lateral shoots may be pared after one fruit was formed. Supporter tip may be provided for some trailing cultivars. Irrigation is required at frequent intervals and a high level of soil moisture should be maintained throughout the growing period. NPK (20: 20: 20) fertilizer should be applied before sowing or planting followed by application of liquid manure every 14 – 21 days until fruit form (Tindal, 1983).

2.7.3 Training and pruning:

Shoots, foliage, flowers and fruits are pruned to maintain a proper balance between the vegetative growth and fruit load to maximize production. Training maximizes the plant's ability to get the light needed for growth. A dense canopy of leaves will shade fruits, causing them to be pale. Flower production depends on the production of shoot and leaf axils. Fruit removal stimulates shoot growth. If too many fruits are allowed to form at any one time, a large proportion will abort because the plant may not have sufficient food reserves. If a heavy load of fruits sets, fruits will be malformed, or poorly colored. Only one fruit should be allowed to develop in a leaf axle. Cucumbers are trained on a string or wire system. The system varies for seedless and seeded cultivars reflecting the growth and fruiting habits of each cultivar. The umbrella system used for seedless varieties is straight forward, not too much demanding labor. For seeded cucumbers, the tree system is used (Vandre, 1990).

2.7.4 Harvesting and handling:

Fruits may be harvested when they are well filled out and show only slight ribbing. The most desirable fruits are 15–18 cm long and weight on the average 120–150 gm. During the peak of production fruits need to be picked three or four times a week. It is advisable to use knife for pruning to avoid damaging the vines and fruits. A healthy plant should produce 30 – 35 marketable fruits over a four month period. Because of their thin skin European cucumber fruits lose moisture rapidly and soften unless precautions are taken. Short–term storage is possible by covering fruits and storing them in a cool moist area. Fruits kept for more than a few hours should be wrapped in clear plastic film and stored at high humidity (90–95%) and low temperature (10–11°C) but do not store at temperatures below 9°C (Tidal, 1983 and Marr, 1995). With good management, each plant may produce as much as 6 – 7 kg of fruits over a four month period. European cultivars are generally harvested when fruit are 15–18 cm. Fruits are often shrink–wrapped to prevent softening by moisture loss. Seedless cooled plastic house cucumbers are distinctly different from traditional field – grown cucumbers. Cooled plastic house cucumbers are preferable by the consumes. Excellent fruits selling characters include seedlessness, dark green color, mild flavor and thin tender skins that require no peeling (Dickerson, 1996). Toshiba variety is seedless variety it has dark green leaves (30–45 cm) diameter with hairy skin, internodes length (10–15 cm), stem diameter (9–13 mm). 3–5 fruits per node and with a good root groups 25–30 cm deep.

2.7.5. Vegetative growth under cooled plastic house conditions:

Cooled plastic house structures were developed for crop production during periods when growing out doors is not feasible. Cooled plastic houses were designed to optimize the penetration of incoming solar radiation. Initially, control of temperature, relative humidity, carbon dioxide, ventilation and air movement were primitive. As plant growing practices improved, better control of the cooled plastic house environment become essential. In highly specialized crop production, all conditions must be controlled uniform in every part of the cooled plastic house for maximum net returns (Sweetman, 2000). Cucumber is one of the major vegetables produced in cooled plastic house. The management of cucumber production is very complicated and requires specialized knowledge (Chen, 2001).

Plants are best started in individual containers. As seeds are often very expensive, sow one seed per container in a sterile potting mix, with the spike end of the seed up (root will emerge facing down). Cover pots with clear polyethylene and place in the shade at (16 – 17° C). Plants will emerge in two to three days. Plastic covering is removed when plants emerge and placed in full sun light. After plants have formed at least two leaves it is transplanted to the growing bed. Cucumbers are heavy feeders requiring 133–178 kg/ha of P_2O_5. Similar quantities of potassium are required for maximum production. Never stress seedlings for water or nitrogen. Cucumber vines can be trained on plastic twine supported from horizontal support wires running the length of the rows (2.1–2.4 m above bed). As the stem develops, it can be fastened to the string with plastic clips. One stem is allowed to develop; all laterals and tendrils are removed.

After the stem reaches the horizontal support wire, it can be trained along the wire and then down another string suspended from the horizontal wire between the two plants in the row. The stem is then allowed to follow the string downwards to within 40 cm of the bed. It is then trained back up the original string with the stem forming a circle. Remove old leaves on the older part of the stem a head of the developing stem terminal. Fruit should develop at each node (Dickerson, 1996). Weed control can be achieved with a good crop rotation system, herbicides, and plastic mulch – in the case of slicing cucumbers. Several pre-plant and post emergence herbicides are available for cucumbers, depending on the specific weed problem and the stage of cucumber growth. If infestation levels are mild early cultivation can help minimize weed problems. The most common diseases include, gray mold, powdery mildew and mosaic viruses, Gray mold becomes a problem when ventilation is poor or low. Powdery mildew is encouraged by high humidity and excessive use of nitrogen fertilizers. Removing the lower leaves and controlling the cooled plastic house humidity is the best defense against these problems. Many viruses are transmitted by aphids from alternative hosts or plants. The best way to keep insects from becoming a problem is to continually monitor and get rid of the problem as soon as it appears. Controlling unwanted vegetation in and around the cooled plastic house will also help to prevent aphid establishment.

2.7.6. Reproductive growth under cooled plastic house conditions:

Fruits may be developed at each node and more than one fruit may begin to develop at some nodes. It is usually best to thin these multiple fruit clusters to a single fruit. The variety Toshiba support several fruits per node usually about 2–4 fruits. Cooled plastic cucumbers production is very popular in the world. The cucumber is a warm season crop which requires growing conditions of (16–17° C) and plenty of sunlight. However, smaller fruits of mini cucumbers have become more popular and commercial production has increased. If pollination does occur, the fruits will form seeds and the shape of the fruit will be distorted and a bitter tasting will develop. It is therefore essential to prevent bees and other pollinating agents to enter the cooled plastic house and bring pollen from out door garden or field cucumber plantings (Hochmuth, 2001).

CHAPTER THREE
MATERIALS AND METHODS

The experiment was conducted at the Horticultural Export Center at Umdom, Khartoum State, for two seasons, the first season during the period October 2005 to February 2006 and the second season during the period April to August 2006.

3.1 The plastic house:

The cooled plastic house is having the following specifications, width of arch 9.0 m, maximum height 3.2 m, length 39 m, distance between first and second arch 2.0 m and distance between other arches is 2.5 m and constructed in an area of about 351m^2 (9 X 39 m). The house is covered by polyethylene sheet and painted by white gypsum to reduce the light intensity to 60%. The fan and pad system is used for cooling the house.

3.1.1 Structural specification:

- The arches are made of 60 mm diameter galvanized steel pipes.
- The arches are linked together with longitudinal galvanized pipes of 32 mm diameter.
- Ground and upper crosses are made of 55 mm diameter galvanized pipes.
- There are 15 crop supports made of 27 mm diameter galvanized pipes, with a single crop holder for each one made of 27 mm diameter galvanized pipes.
- Windbreakers are made of 32 mm diameter galvanized pipes.

- The front frame of the greenhouse is made of (30 x 30) mm cross-section galvanized tubes.

One small door is attached on the front side (Fan side).

3.1.2 Cover:

The house is covered by Ultra Violet treated polyethylene which is 200 microns thick except the front and the rear sides which are covered with fiberglass.

3.1.3 Cooling system:

Cooling system consists of the following:

1. Two exhaust fans, each fan exhausting 44500 m^3/hr.
2. Cooling pads 12 m^2 (2 m x 6 m) x 10 cm on the rear of the greenhouse.
3. Water gutters with all accessories made from galvanized steel.
4. Thermostats to control the operation of fans and water pump.
5. One electrical control panel with cables connecting all equipments.
6. Tank (1000 l) used to support the pad with cooling water.
7. Small submergible single phase electric pump (400 W). Type DP60 G, Made in Italy, used for pumped circulation water for wetting pad.

3.2 Land preparation:

The land was ploughed three times. During ploughing 0.014 m^3 /m^2 of sand and 0.0057 m^3/ m^2 of chicken manure were added, then leveled and six beds were made each one 50 cm wide. The 6 beds were divided into 42 plots each one 2.5 m^2 in area. Spilt plot design with three replicates was used. Cucumber seeds were treated with Thiram and sown directly in the soil at 40 cm spacing, one seed per hole.

Drip irrigation system was used and water was applied for 15 minutes every two days. The total amount of irrigation water applied was about 202.5 l/day during the first 15 days after planting. Then the water applied was raised to half an hour every two days, giving 405 l/day. This gave each plant 0.2 l/ day during the first period, 0.4 l/day during the second period. The irrigation system was calibrated and each emitter was adjusted to give a constant flow rate of 3 l/hr.

The plants were fertilized by complete NPK and micronutrients were applied with irrigation water (fertigation). 10 days after planting with ½ kg of NPK (20: 20: 20) every two days which was applied during 15 minutes of irrigation. After flower ½ kg NPK (20: 20: 20) + ½ kg NPK (10: 10: 43) also every two days which was applied during 30 minutes of irrigation. 21 days the first dose of nitrogen was applied (0, 5, 10, 15, 20, 25 and 30 gm of nitrogen) and the second dose after 43 days.

The plants were also sprayed with foliar fertilizers, pesticides, fungicides acrocides and insecticides. Pruning operation for the side branches and yellow leaves was done. Maintenance of the cooling pad, tank of water and filters, was done weekly.

3.3. The treatments:

Irrigation with magnetized water and non-magnetized water treated with different levels of nitrogen is as followeds:

Treatments No.	MW	NMW
1	0	0
2	10	10
3	20	20
4	30	30
5	40	40
6	50	50
7	60	60

3.4. Magnetizing device:

The device is a plastic body with an output of 2 m^3/hr. It is used in agriculture and at home for irrigation of small areas with municipal water or water that goes through preliminary filtration.

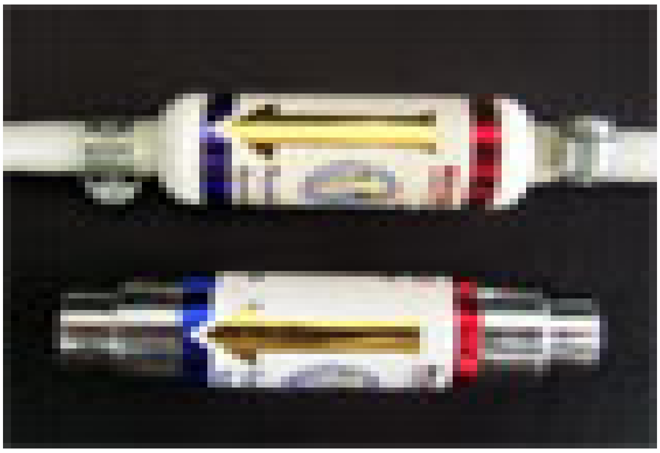


Plate (1): Magnetizing device.

3.5. Drip irrigation system components:

The components required for trickle systems are generally more complicated than those for other application systems due to the need to filter the water supply and to maintain a specific pressure distribution throughout the systems. The system can be divided into the mainline, sub main and lateral. The mainline has a pump to pressurize the system and a chemical injector to conveniently apply nutrients through the distribution system. Primary filter is used to screen the largest particles out of the system. Primary pressure gauges on either side of the filter are used to evaluate when pressure drop across the filter is high enough to require back – flushing. The final components on the main line are control valve, pressure and flow regulators. The sub-mainline has a secondary filter for finer particles and solenoid valve to aid in system automation. A pressure regulator is required on this line to keep the system operating within the close tolerances of discharge necessary. For the water balance, secondary pressure gauges were used to verify the operating pressure. Flush valves were placed at the end of the sub-mainline to periodically clear accumulated debris from the line. The lateral lines distribute water to the emitters which deliver water directly to the root zone.

3.5.1 Pump:

Irrigation pumps force the water to create machine pressure for the designed system. A submersible pump (10 Hp) was used for irrigation. Its mechanism uses an impeller to spin water rapidly in tank. This type of pump must have in case there is small valve to hold water. Submersible pumps are the most common pumps in drip systems, submersible usually shaped like along cylinder to match the works inside the wells. Submersible pumps are the most efficient type of pumps that can be used in wells.

3.5.2 Control head:

The head works consist of the main control station and consist of the submersible pump, filters, pressure regulating, valves, flow regulating valves, control valves, pressure gauge, and chemical injection equipment.

3.5.3 Valves:

A valve is advice to control the flow of water, valves are divided into:

(a) Emergency shut-off valves which should be located at the way of the water to the system. The valves used were ball valves.

(b) Control valves can be operating manually, Valves are either made of brass or plastic, in salty water operating used plastic valves because it is not tear and wear.

(c) Backflow prevented valve located before the tank to prevent the flow back of water to Submersible pump.

3.5.4 Pressure and flow regulators:

Installed in the mainline to save the system from an increase in the pressure and regulate the flow.

3.5.5 Filters:

Filters are essential components of the drip system their aim is to minimize or prevent emitter clogging; the type of filtration needed depends on water quality an emitter type. Two filters were used a main filter (63 mm) this located after the chemical injection equipment, a sub main filter (2.5 mm) located before the lateral lines.

3.5.6 Fertilizing and chemical injection:

The injection system is used to add chemicals (nutrients and pesticides) to the irrigation water are considered an integral part of the drip system. The process of adding fertilizer with irrigation water is called fertigation, the solubility of fertilizer must be known, and the system or advice must be calibrated.

3.5.7 Main, submain and lateral lines:

These supply water from the control head into the green house, the main line (63 mm), submain line (2.5 mm) and lateral (13 mm).these are made of polyethylene (PE).

3.5.8 Emitters:

These devices are used to control water flow from the lateral lines into the soil. The emitters used are of (ADRILINE) type, 16 mm, flow 3 l/hr, spacing 40 cm and length 400 m.

3.6 Germination rate:

Calculated as percentage by divided the number of germinated seeds into the total number of seeds down.

$$\text{Germination rate (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds}} \times 100$$

3.7 Measurements:

All measurements have been taken weekly for the two seasons.

3.7.1 Parameters:

Plant growth parameters include, plant height, number of leaves per plant, leaf area, internodes length, time of flowering, and number of flowers per plant.

3.7.1.1 Plant height (cm):

Plant height was determined by measuring the length of the plant from the soil surface to the growing tip.

3.7.1.2 Internodes length (cm):

Internodes length was determined by measuring the third internode from 5 plants labeled at the middle of the plots.

3.7.1.3 Number of leaves per plant:

Leaf number was recorded for 5 plants labeled at the middle of the plots.

3.7.1.4 Stem diameter (mm):

Stem diameter was determined from mark point at the same place of the third internode for every 5 plants of each treatment.

3.7.1.5 Leaf area (cm^2):

Leaf area was determined by measuring the maximum leaf length × maximum leaf width from 5 plants labeled at the middle of the plots.

3.7.1.6 Length of fruit (cm):

The fruit length determined by measuring from 5 fruits and gave the mean of them from 5 plants from middle of the plots.

3.8 Flowering:

The time of flowering and number of flowers per plant were determined.

3.8. 1 Time of flowering:

The number of days from sowing to first flower appearance indicates flowering time for the two kinds of water, magnetized water and non-magnetized water

3.8.2 Number of flowers:

The number of flowers per plant was recorded weekly from 5 plants labeled at the middle of the plots.

3.9 Fruit set:

Number of fruits per plant was determined by number of flowers which set into fruits.

3.9.1 Yield:

The yield in the two seasons had been determined by both fruit number per m^2 and weight kg/m^2.

3.9.2 Fruit quality:

The fruit size, length, diameter, shape, colour, smoothness and T.S.S were used to determine fruit quality for the different treatments.

3.9.3 Total soluble solids

T.S.S was determined by measuring from 5 fruits and gave the mean of them from 5 plants from middle of the plots.

3.9.4 Fruit panel test:

Fruit panel test by 5 persons, were used to test acceptability of fruits by the customers. Score of 1- 5 was used to evaluate color, taste, crispiness and appearance.

3.10 The water analysis:

The chemical composition of water were determined by lab analysis, from two type of water, one of them pass directly through magnetic device.

3.11 The soil analysis:

The soil chemical compositions were determined by lab analysis, from 42 samples of soil.

3.12 The fruit analysis:

The fruit chemical compositions were determined by lab analysis, from 42 samples of fruit.

CHAPTER FOUR

RESULTS AND DISCUSION

4.1 Germination:

Germination percentages were recorded as shown in Table (1) and Fig. (1) They were 97% for magnetized water and 93% for non-magnetized water respectively with an increase of 4.1% in the means of two seasons. These results agree with Saeed, (2006) who found that the germination percentage increased by 9.8% for cucumber irrigated with magnetized water.

4.2 Plant height (cm):

For the two seasons plant height was higher for magnetized water which gave 357.7 cm compared to non-magnetized water which gave 326.2 cm by an increased of 8.8% as shown in Table (2) and Fig. (2). Also the dose of 40 gm nitrogen with magnetized water gave a mean of 363.2 cm while with non-magnetized water it gave 340.4 cm with an increased by 6.3% as shown in Table (2) and Fig. (2). for the two seasons, the plants irrigated by magnetized water gave higher plants. This may be attributed to the fact that magnetized irrigation water reduced salinity of the water and soil and increased absorption of dissolved minerals in the soil. Since the plant more readily absorb fertilizers and nutrients won't be wasted by leaching, hence more saving on fertilizer bills will be achieved deltawater.com, (2006). These results were not different from the results obtained by Helal, (1999) who found an increase of 16.7% in plant height of cucumber irrigated by magnetized water they also agree with Eljack, (2001) who found that Sorghum vulgare irrigated by magnetized water increased by 28.3% in height and with Saeed, (2006) who found that height of cucumber irrigated by magnetized water increased by 15.7%.

4.3 Internodes length (cm):

As shown in Table (3) and Fig. (3) for the two seasons magnetized water gave 13.5 cm internodes length while non-magnetized water gave 13 cm with an increase of 3.7 %. Also the dose of 40 gm nitrogen with magnetized water gave 14.7 cm while with non-magnetized water gave 14.2 cm with an increase of 3.4%.

4.4 Number of leaves per plant:

For the two seasons the leave number was higher for magnetized water being 128.2 as compared to 120.2 for non-magnetized water with an increase of 6.3 % as shown in Table (4) and Fig (4). Also the dose of 40 gm nitrogen with magnetized water gave 131.9 as compared to the treatment 40 gm nitrogen with non-magnetized water which gave 123.9 with an increase of 6.1 % as shown in Table (4) and Fig (4). These results agree with those obtained by Waspodo, (1999) who found that an increase of 19.1% in the number of leaves of cucumber irrigated with magnetized water.

4.5 Stem diameter (mm):

For the two seasons, stem diameter for plants irrigated with magnetized water was 9.9 mm and for the non-magnetized water it was 9.8 mm with an increase of 0.1 % as shown in Table (5) and Fig. (5). The 40 gm nitrogen dose with magnetized water it gave stem diameter of 10.2 mm while with non-magnetized water gave stem diameter of 10 mm with an increase of 0.2% as shown in Table (5) and Fig. (5) this result agrees with Waspodo, (1999) who found that there was no significant difference between magnetized water and non-magnetized water for stem diameter.

4.6 Number of flowers:

For the two seasons the number of flowers for magnetized water was 173.6 mean while, non-magnetized water gave 155.3 with an increase of 10.5 % as shown in Table (6) and Fig (6). Also the dose of 40 grams nitrogen with magnetized water gave 181.5 compared with 40 grams nitrogen with non-magnetized water which gave 164.3 with an increase of 9.7% as shown in Table (6) and Fig. (6).

4.7 Leaf area (cm^2):

For the two seasons the leaf area was larger for magnetized water being 955.8 cm^2 as compared with 886 cm^2 for non-magnetized water with an increase of 7.3 % as shown in Table (7) and Fig. (7). Also the dose of 40 gm nitrogen with magnetized water gave 972.5 cm^2 compared with 905.2 cm^2 for 40 gm nitrogen with non-magnetized water with an increase of

6.9% as shown in Table (7) and Fig (7). These results agree with Waspodo, (1999) who found an increase of 3.8% for cucumber irrigated by magnetized water. The results obtained in this study were higher than those of Waspodo, (1999) this may be attributed to the intensive nitrogen fertilization used.

4.8. Length of fruits (cm):

For the two seasons the magnetized water gave a mean length of fruit of 15.8 cm on the other hand non-magnetized water gave 15 cm with an increase of 5.1% as shown in Table (8) and Fig. (8). Also the dose of 40 gm nitrogen with magnetized water gave 17.6 cm as compared with 15.9 cm for 40 gm nitrogen with non-magnetized water with an increase of 10.7% as shown in Table (8) and Fig. (8). This agrees with Saeed (2006) who found that for cucumber irrigated by magnetized water the length of fruit increased by 4.3%.

4.9. Total soluble solids:

For the two seasons the total soluble solids in fruits gave the higher percentage 2.6 for magnetized water as compared with non-magnetized water 2.5 with an increase of 3.9% as shown in Table (9) and Fig. (9). Also the dose 40 gm nitrogen with magnetized water gave 2.63 as compared with 60 gm nitrogen with non-magnetized water 2.6 by increased 1.14% as shown in Table (9) and Fig (9).

4.10 Fruits number/m^2:

For the two seasons the fruits numbers per m^2 for magnetized water gave 49.7 compared with 37 for non-magnetized water by increased 25.7% as shown in Table (10) and Fig. (10). Also the dose 40 gm nitrogen with magnetized water gave 52.5 compared with 38.1 for 40 gm nitrogen with non-magnetized water by increased 27.4% as shown in Table (10) and Fig. (10). This agrees with Eljack, (2001) who found that the number of heads per square meter increased by 25% for Sorghum vulgare irrigated by magnetizes water. Also agrees with Saeed, (2006) who found that the number of fruits of cucumber irrigated by magnetized water increased by 25.3%.

4.11 Weight of fruits (kg/m^2):

For the two seasons the weight of fruits per m^2 was higher for magnetized water being 6.1 kg/m^2 as compared with 4.2 kg/m^2 for non-magnetized water result with an increase by 30% as shown in Table (11) and Fig. (11). Also the doses 40, 50 gm nitrogen with magnetized water gave 7.2 kg/m^2 as compared with 4.8 kg/m^2 for 40 gm nitrogen with non-magnetized water giving an increase of 33.3% as shown in Table (11) and Fig. (11) this agrees with a cucumber grower in United Kingdom who reported that his harvest increased by 85% deltawater.com (2006). Also magnetically treated irrigation water has increased the yield of wheat 12.7- 33% Helal, (1999). The results were also found to be in agreement with Saeed, (2006) who found that the weight of cucumber irrigated by magnetized water increased by 51.4%.

The treatment of 40 gm nitrogen with magnetized water excelled the whole treatment for the whole measured parameters. This agrees with the results by Taha, (1982) who found that tomato fertilized by three doses of nitrogen, 0, 90, 180 kg/ ha, the early yield were given the higher 21.53% for 90 kg/ha, the minimum 21.43% for 180 kg/ha and the lowest 21.06% for 0 kg/ha nitrogen. Also agreed with Ahmed, (1982) who found that the early yield for sweet pepper fertilized by four doses of nitrogen 0, 40, 80, 120 kg/ ha, was found to be 7.84, 7.37, 6.73 and 4.31 tons/ha for 40, 80, 120 and 0 kg/ha treatment respectively.

4.12 Fruits quality:

Fruits taste:

For the two seasons the fruits taste gave the best taste at magnetized water which gave 3.5 compared with non-magnetized water 3.3 by increased 5.7 % as shown in Table (12) and Fig. (12). Also the dose 30, 40 gm nitrogen with magnetized water 3.7 compared with 20, 30 gm nitrogen with non-magnetized water 3.6 by increased 2.7% as shown in Table (12) and Fig. (12). All these parameters are agrees with the results of UK grower reported, they said that “Our traditional cucumber sandwiches were tastier and more succulent with magnetizer grown cucumbers deltawater.com. (2006).

Skin color:

For the two seasons the skin color of fruits gave the dark green color at magnetized water which gave 3.4 compared with non-magnetized water 3.3 by increased 2.9% which shows in Table (13) and Fig. (13). Also the dose 20 gm nitrogen with magnetized water 3.8 compared with 40 gm nitrogen with non-magnetized water 3.8 with no different between them as shown in Table (13) and Fig. (13).These results are agreed with the grower of U. K, cucumbers with magnetizes water giving more succulent fruits deltawater.com (2006).

Skin appearance:

For the two seasons the skin appearance of fruits gave the best appearance at magnetized water which gave 4.8 compared with non-magnetized water 4.2 increased by 1.3% as shown in Table (14) and Fig. (14). Also the doses 30 and 40 gm nitrogen with magnetized water 4.7 compared with 40, 50 gm nitrogen with non-magnetized water 4.6 increased by 2.1% as shown in Table (14) and Fig. (14).

4.13. The water analysis:

The results in the Table (15) and Fig. (15) shows that the magnetization of water increased the pH by 4%, and reduced the ECe by121%, (Ca + Mg) by 7%, Na by 2.9%, and K by 400%.

4.14 The soil analysis:

The results in Table (16) and Fig. (16) Show that the magnetization technology reduced the pH by 4%, and the ECe by 32%. This makes the plants absorb the minerals from soil easily. For instance absorption of Ca and Mg increased by 10%, and that of Na, P and K increased by 26%, 5% and 25% respectively, but increased (fixed) the nitrogen by 30%. This agrees with Hilal, (2002) who found that induced magnetism increased of nutrient extraction from soil. This was highest for Fe; since extracted Fe reached 9 times as much as that extracted under normal conditions. Zinc increased 5 times and P increased 3 times Hilal, (2002).

4.15 The fruits analysis:

Table (17) and Fig. (17) shows that there is an increase in the compositions of fruits irrigated by magnetized water, eg. Ca increased by 17.2%, K increased by 2.1%, N increased by 8.3%, and P increased by 3.2%, also it reduced Mg by 8.3%, and Na fruit content decreased by 5.6%.

Table (1) Effect of MW and NMW on germination rate %.

Water	Magnetized	Non-magnetized
First season	98.4%	93.2%
Second season	95.6%	92.8%
Means of two seasons	97%	93%

Table (2) Effect of MW, NMW and N on Plant height (cm): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	358.3	359.1	359.5	363.3	366.3	357.2	354.3	359.7^{a}	1.5
NMW	343	345.5	346.5	345.3	350.4	346..2	342.9	345.7^{b}	
Means	350.7^{d}	352.3^{c}	353^{c}	354.3^{b}	358.4^{a}	351.7^{c}	348.6^{e}		
LSD	1.93								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	356	355.7	357	355	360	355.7	350.7	355.7^{a}	2.5
NMW	339.6	343.9	346.5	347.9	351.2	347.8	345.9	346.1^{b}	
Means	347.8^{b}	349.8^{b}	351.8^{b}	351.5^{b}	355.6^{a}	351.8^{bc}	348.4^{c}		
LSD	2.9								

Means with the same letter are not significantly different.

Table (3) Effect of MW, NMW and N on length of Internodes (cm): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	12.7	14	14.3	14	14.7	12.7	12	13.5^{a}	2.018
NMW	12	13	13.3	13.7	14	12.7	12	12.9^{b}	
Means	12.3^{c}	13.5^{b}	13.8^{ab}	13.8^{ab}	14.3^{a}	12.7^{c}	12^{c}		
LSD	0.72								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	12.7	13.3	14.3	13.7	14.7	13	12.3	13.4^{a}	0.66
NMW	12	13	13.3	13.3	14.3	12.7	12.3	13^{b}	
Means	12.3^{de}	13.2^{cd}	13.8^{b}	13.5^{bc}	14.5^{a}	12.8^{d}	12.3^{de}		
LSD	0.36								

Means with the same letter are not significantly different.

Table (4) Effect of MW, NMW and N on leaves Number/plant: First season

N	0	10	20	30	40	50	60	Means	LSD
MW	129.7	130.3	132.3	134	137	134	132	132.8^{a}	1.68
NMW	111.7	109.7	110.7	112.7	112	112	112	112^{b}	
Means	120.7^{bc}	120^{c}	121.5^{bc}	123.3^{ab}	126^{a}	123^{ab}	122^{bc}		
LSD	3.23								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	122	121.3	123.7	125	126.7	124.7	121.3	123.5^{a}	2.6
NMW	111.3	110.7	112.7	112.7	114.3	111.7	110.3	112^{a}	
Means	116.7^{c}	116^{c}	118.2^{b}	118.8^{b}	120.5^{a}	118.2^{b}	115.8^{c}		
LSD	1.44								

Means with the same letter are not significantly different.

Table (5) Effect of MW, NMW and N on Stem diameter (mm): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	9.7	10.3	9.3	9.3	10.3	9.7	9.7	9.8^{a}	0.74
NMW	9.7	9.7	10	10	10	9.3	10	9.7^{a}	
Means	9.7^{ab}	10^{ab}	9.7^{ab}	9.7^{ab}	10.2^{a}	9.5^{b}	9.8^{ab}		
LSD	0.83								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	10	10	9.8	10.2	10	10	9.8	9.97^{a}	0.3
NMW	9.8	9.8	9.8	9.8	10	10	9.7	9.85^{b}	
Means	9.9^{a}	9.9^{a}	9.8^{a}	10^{a}	10^{a}	10^{a}	9.75^{a}		
LSD	0.1								

Means with the same letter are not significantly different

Table (6) Effect of MW, NMW and N on Number of flowers/plant: First season

N	0	10	20	30	40	50	60	Means	LSD
MW	158.7	163	170	174	176.3	169.3	164.3	168^{a}	4.9
NMW	147.7	147	151.3	157.3	165.3	159.7	157	155.1^{b}	
Means	153.2^{d}	155^{d}	160.7^{c}	165.7^{b}	170.8^{a}	164.5^{bc}	160.7^{c}		
LSD	4.8								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	171	174.7	179.7	184.7	186.7	181	176	179.1^{a}	3.9
NMW	149	150.3	155.3	160.7	163.3	151.7	149.7	154.6^{b}	
Means	160^{d}	162.5^{cd}	167.5^{b}	173.7^{a}	175^{a}	166.3^{b}	162.8^{c}		
LSD	2.8								

Means with the same letter are not significantly different.

Table (7) Effect of MW, NMW and N on Leaf size (cm): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	941	934.7	942.3	949	959.3	950.3	947.3	945.9^{a}	20.74
NMW	882.3	912	920	927.7	933	930	928.7	919.1^{b}	
Means	911.7^{b}	923.3^{ab}	931.2^{ab}	938.3^{a}	944.7^{a}	940.2^{a}	938^{a}		
LSD	24.31								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	948.3	962	965.7	972	985.7	968.3	957.3	965.6^{a}	50.2
NMW	832.7	838.3	857.3	867.7	877.3	859.3	837.7	852.9^{b}	
Means	890.5^{c}	900.2^{c}	911.5^{b}	919.8^{b}	931.5^{a}	913.8^{b}	897.5^{c}		
LSD	10.1								

Means with the same letter are not significantly different.

Table (8) Effect of MW, NMW and N on Length of fruits (cm): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	14.8	15.7	15.8	16.4	18	15.2	14.5	15.8^{a}	0.65
NMW	13.9	14.4	14.7	15.3	15.6	14.8	14.2	14.7^{b}	
Means	14.3^{d}	15^{c}	15.2^{c}	15.9^{b}	16.8^{a}	15^{c}	14.3^{d}		
LSD	0.38								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	14.9	15.4	15.7	16.3	17.1	15.2	15	15.7^{a}	0.22
NMW	14.5	14.9	15.1	15.6	16.1	15.2	14.9	15.2^{b}	
Means	14.72^{e}	15.2^{cd}	15.4^{c}	15.9^{b}	16.6^{a}	15.2^{cd}	14.95^{d}		
LSD	0.18								

Means with the same letter are not significantly different

Table (9) Effect of MW, NMW and N on T.S.S (%), First season.

N	0	10	20	30	40	50	60	Means	LSD
MW	2.4	2.4	2.5	2.5	2.6	2.6	2.6	2.5^{a}	0.125
NMW	2.2	2.2	2.2	2.3	2.3	2.3	2.6	2.2^{b}	
Means	2.3^{b}	2.3^{b}	2.4^{ab}	2.4^{ab}	2.5^{a}	2.5^{a}	2.4^{ab}		
LSD	0.127								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	2.7	2.64	2.7	2.64	2.7	2.63	2.61	2.7^{a}	0.17
NMW	2.5	2.5	2.6	2.63	2.63	2.5	2.54	2.6^{a}	
Means	2.6^{b}	2.6^{b}	2.64^{ab}	2.64^{ab}	2.7^{a}	2.6^{b}	2.6^{b}		
LSD	0.08								

Means with the same letter are not significantly different

Table (10) Effect of MW, NMW and N on Number of fruits/m²: First season

N	0	10	20	30	40	50	60	Means	LSD
MW	57.6	58.9	59.7	60.2	64.3	60.8	59.0	60.3^{a}	25.52
NMW	38	38.5	38.7	39.2	40	39.2	36.1	38.5^{b}	
Means	47.8^{cd}	48.7^{bc}	49.2^{bc}	49.7^{b}	52.15^{a}	50^{b}	47.6^{d}		
LSD	2.19								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	39	39.1	39	39.8	40.6	40	39.1	39.13^{a}	3.094
NMW	35	35.2	35.4	35.6	36.1	35.6	35	35.4^{b}	
Means	37^{d}	37.2^{d}	37.23^{cd}	37.7^{bc}	38.4^{a}	37.8^{b}	37.1^{d}		
LSD	1.16								

Means with the same letter are not significantly different.

Table (11) Effect of MW, NMW and N on Weight of fruits (Kg/m²): First season

N	0	10	20	30	40	50	60	Means	LSD
MW	6.63	6.97	7.04	7.35	8.82	7.36	6.56	7.24^{a}	1.62
NMW	4.18	4.4	4.52	4.88	5.31	4.76	4.39	4.62^{b}	
Means	5.41^{d}	5.69^{c}	5.78^{c}	6.11^{b}	7.07^{a}	6.06^{b}	5.48^{d}		
LSD	3.35								

Means with the same letter are not significantly different.

Second season

N	0	10	20	30	40	50	60	Means	LSD
MW	3.23	4.61	4.78	5.06	5.54	4.96	4.49	4.67^{a}	1.647
NMW	3.34	3.54	3.71	3.98	4.29	3.69	3.45	3.71^{b}	
Means	3.29^{c}	4.08^{b}	4.244^{ab}	4.51^{ab}	4.92^{a}	4.33^{ab}	3.97^{bc}		
LSD	1.87								

Means with the same letter are not significantly different

Table (12) Effect of MW, NMW and N on taste of fruits for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	3.2	3.4	3.8	3.7	3.7	3.3	3.4	3.5
NMW	3.1	3.3	3.6	3.6	3.5	3.2	2.6	3.3

Table (13) Effect of MW, NMW and N on fruit color for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	3.1	3.4	3.8	3.4	3.2	2.9	2.6	3.4
NMW	2.8	3.1	3.3	3.6	3.8	3.4	3	3.3

Table (14) Effect of MW, NMW and N on fruits appearance for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	4.3	4.2	4.3	4.7	4.7	4.2	4	4.8
NMW	3.7	4.1	4.3	4.5	4.6	4.6	3.7	4.2

Table (15) Chemical composition of water:

Water	pH	ECe(ds/m)	Ca+Mg(mmol+/l)	Na(mmol+/l)	K(mmol+/l)
MW	7.82	0.95	2.8	8.26	0.04
NMW	7.49	2.1	3	8.5	0.2

Table (16) Chemical composition of soil (depth, 30-40cm):

Indicators Flushing contents	(1)Analysis before planting	(2)Content after flushing (regular water)	(3)Content after flushing (magnetized water)
pH	7.56	7.21	7.18
ECe (ds/m)	2.9	1.19	0.9
Ca + Mg (mmol+1/l)	5.6	3.85	3.5
Na(mmol+1/l)	20.1	7.3	5.8
N %	0.66	0.74	0.96
P(mg/l)	1.36	0.93	0.62
K %	0.15	1.26	1.1

*Changes in the soil composition after flushing the soil by usual and magnetized water.

Table (17) The chemical composition of fruits.

Contains	Ca%	Ma%	Na%	K%	N%	P%
Magnetized water	0.75	0.24	0.18	4.9	3.9	25.5
Non-magnetized water	0.64	0.26	0.19	4.8	3.6	24.7

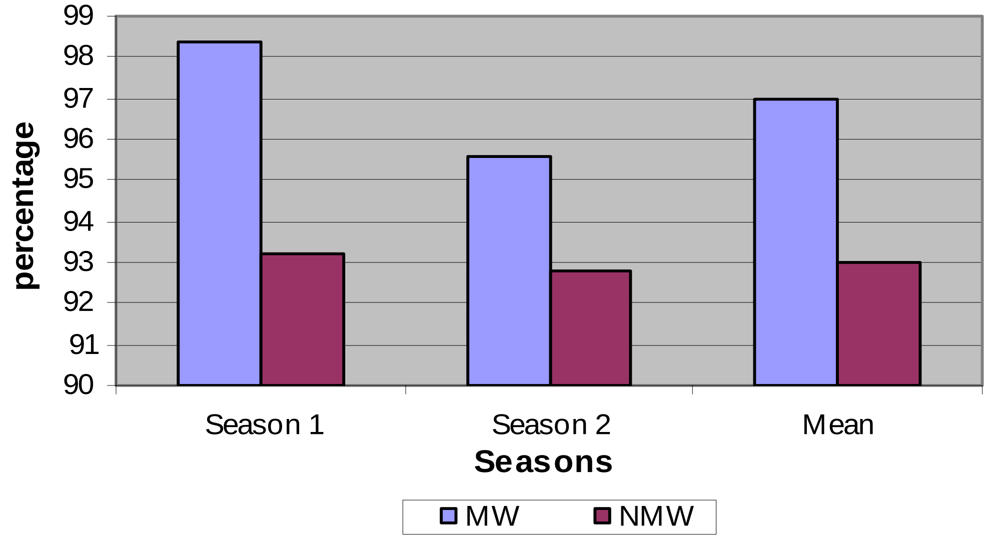


Fig:(1) Effect of MW and NMW on germination rate %.

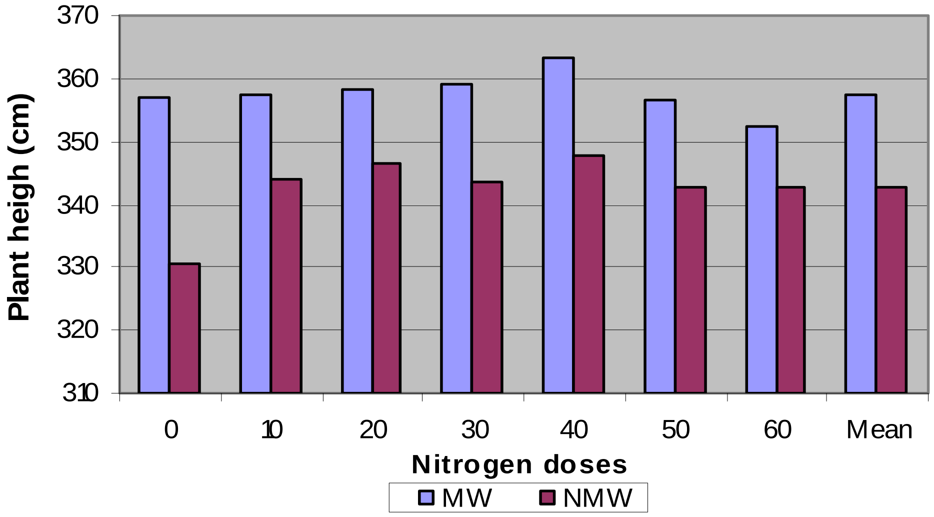


Fig:(2) Effect of MW, NMW and different doses of N on plant height (cm).

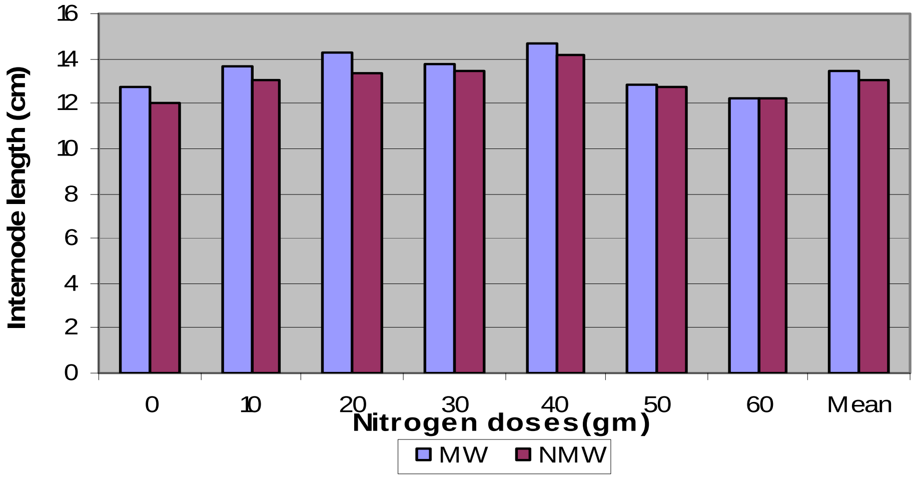


Fig:(3) Effect of MW,NMW and different doses of N on length of internode (cm).

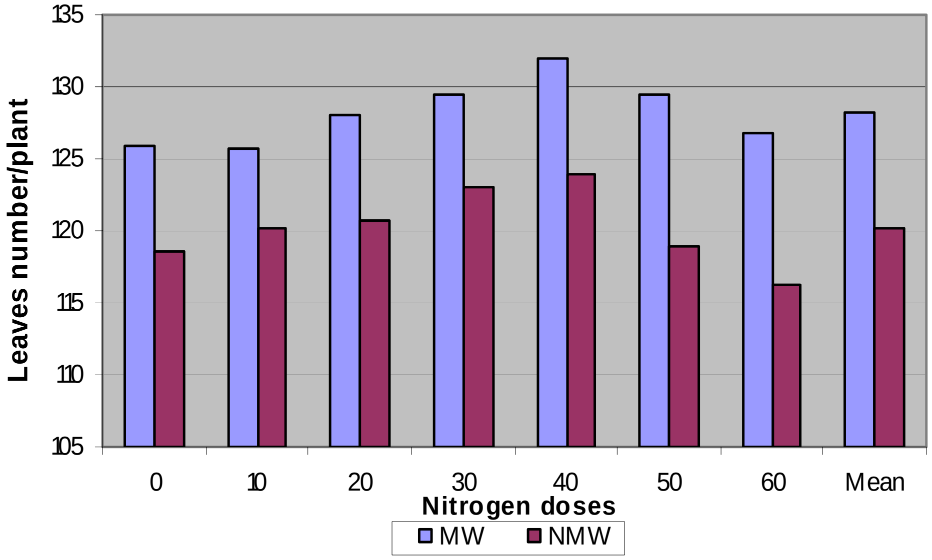


Fig:(4) Effect of MW, NMW and different doses of N on leaves number/plant.

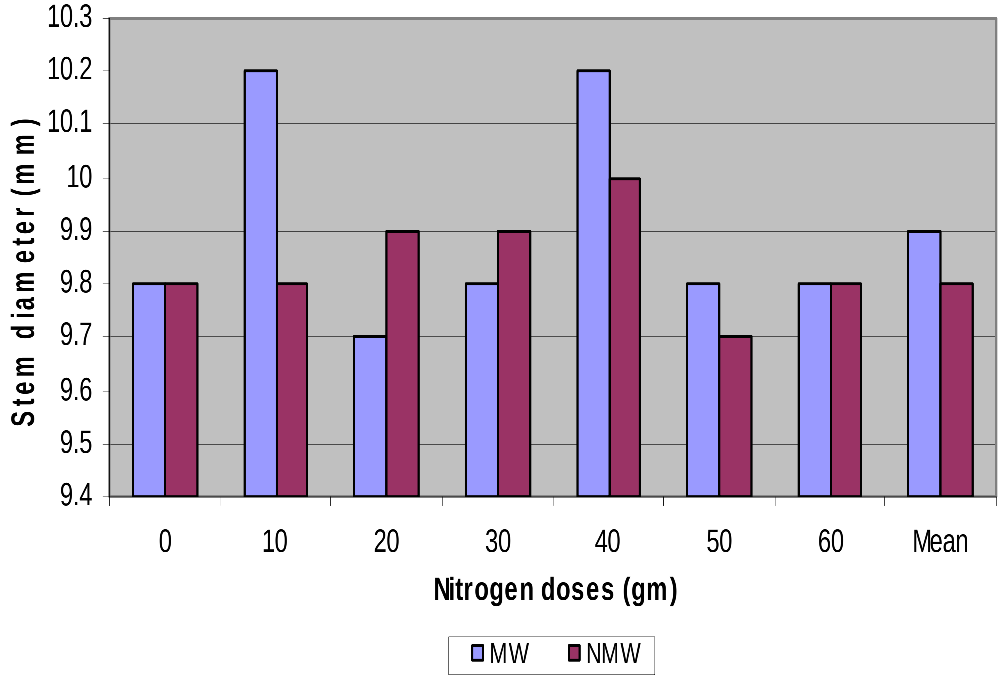


Fig:(5) Effect of MW, NMW and different doses of N on stem diameter (mm).

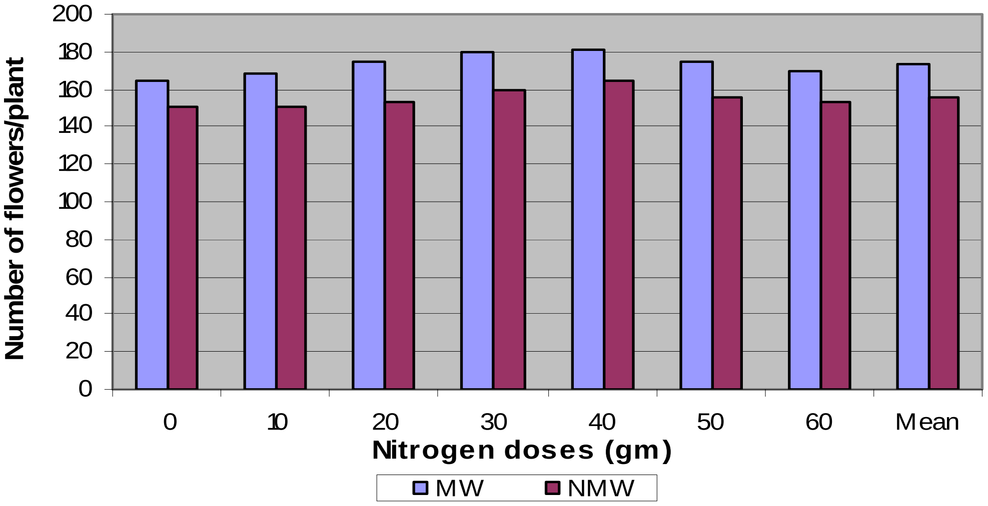


Fig:(6) Effect of MW, NMW and different doses of N on number of flowers/ plant

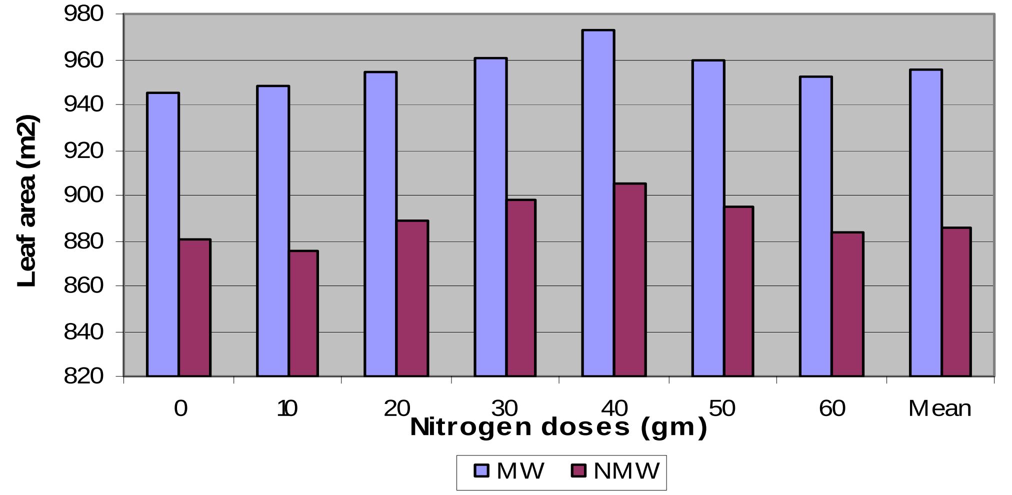


Fig:(7) Effect of MW, NMW and different doses of N on leaf area (m2)

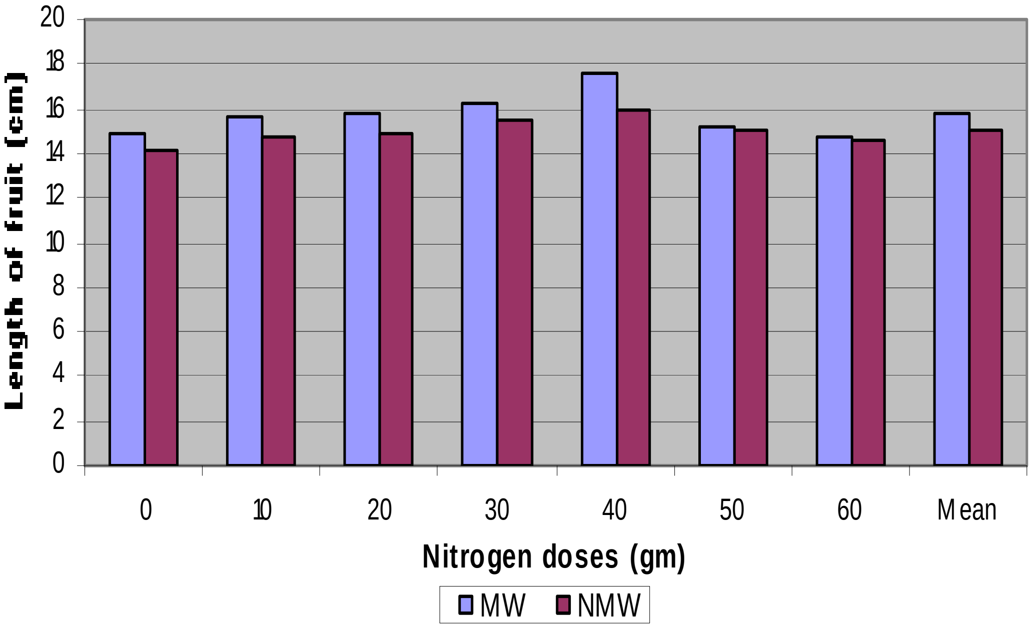


Fig:(8) Effect of MW, NMW and different doses of N on length of fruit (cm).

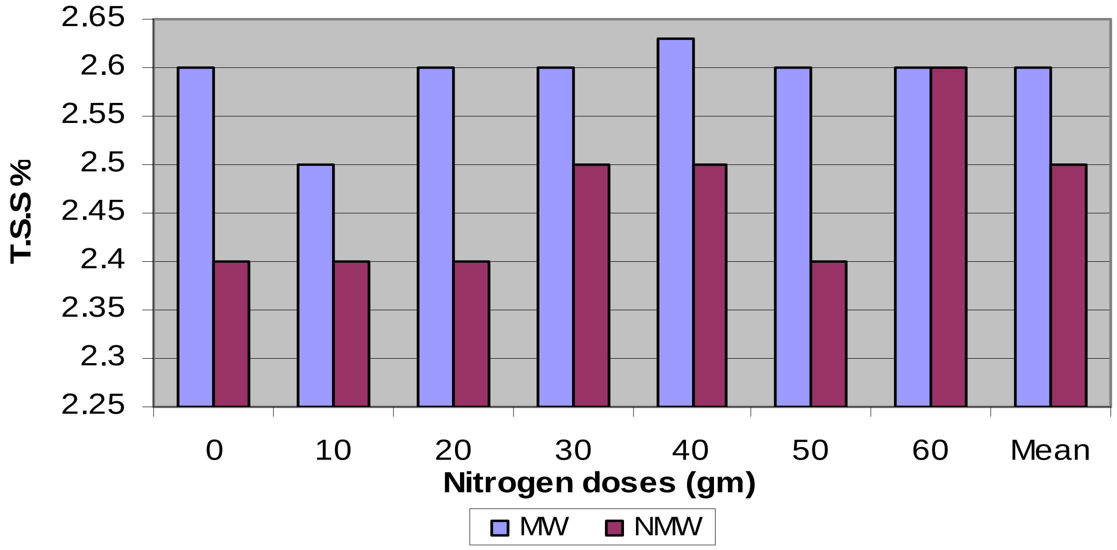


Fig:(9) Effect of MW, NMW and different doses of N on T.S.S %

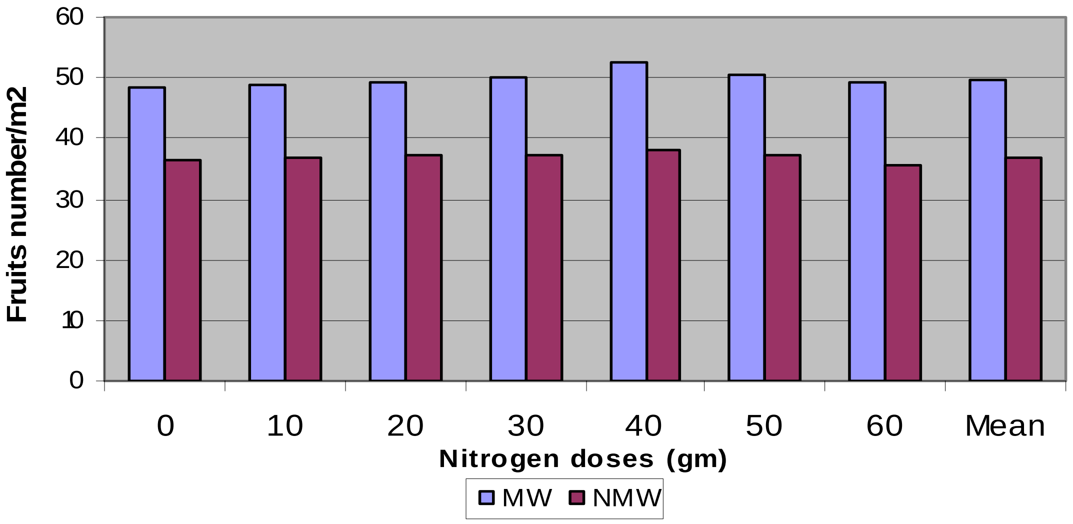


Fig:(10) Effect of MW, NMW and different doses of N on fruits number/ m2

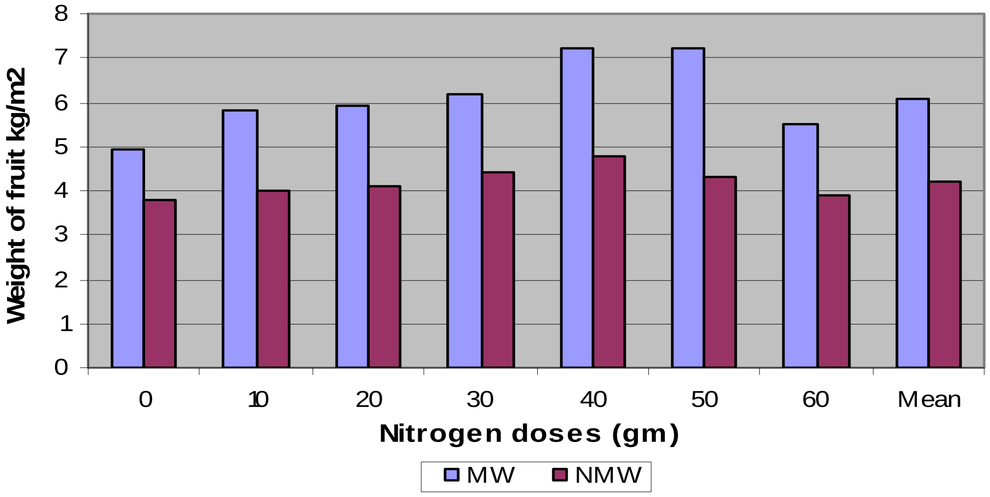


Fig:(11) Effect of MW, NMW and different doses of N on weight of fruit kg/m2.

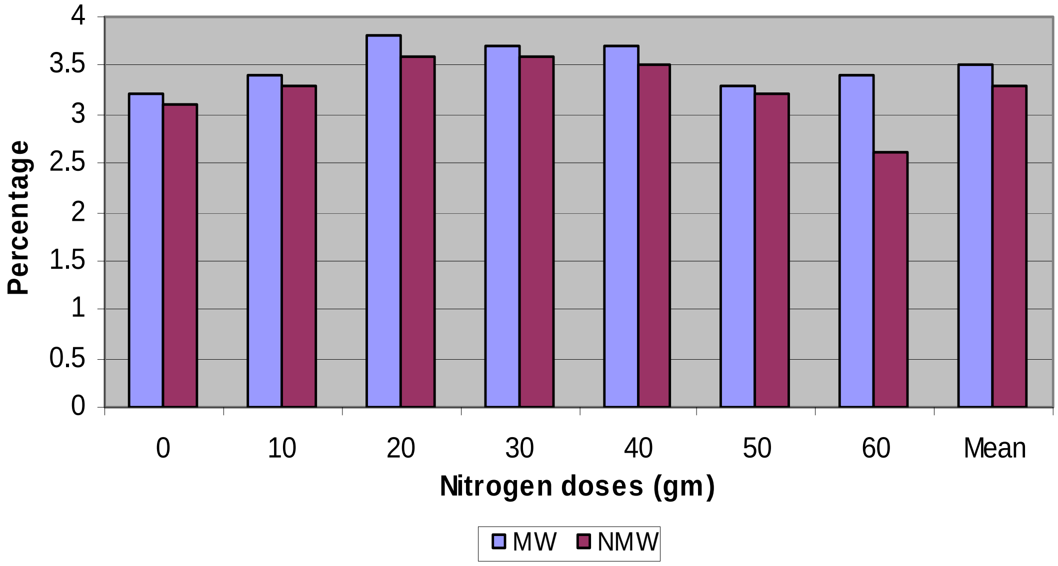


Fig:(12) Effect of MW, NMW and different doses of N on taste of fruit.

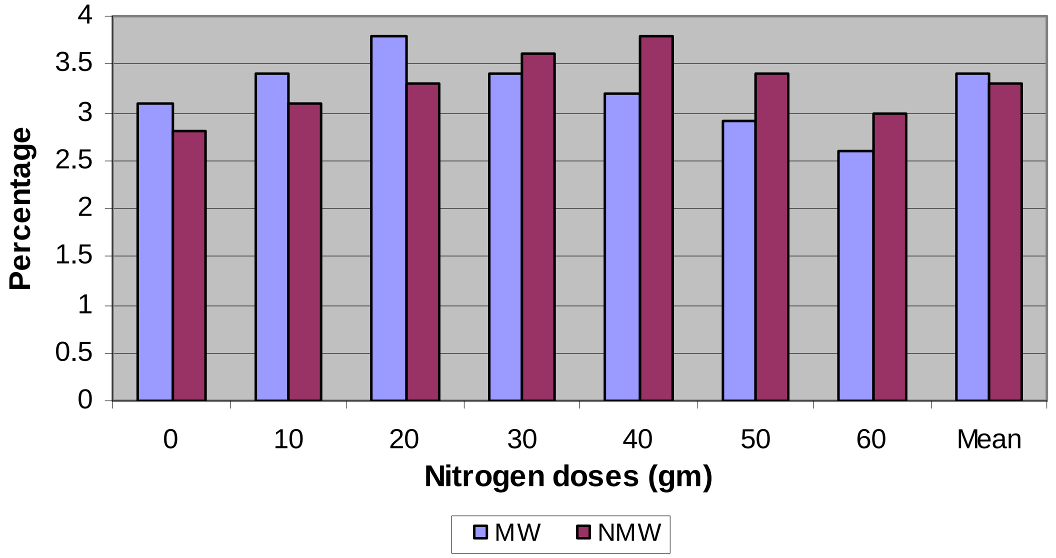


Fig:(13) Effect of MW, NMW and different doses of N on fruit color.

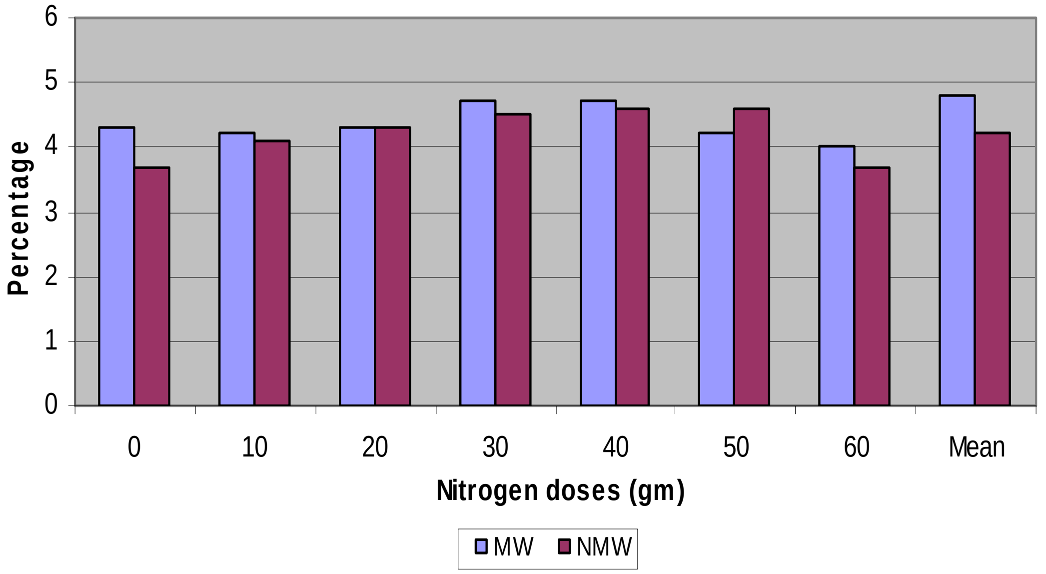


Fig:(14) Effect of MW, NMW and different doses of N on fruit appearance.

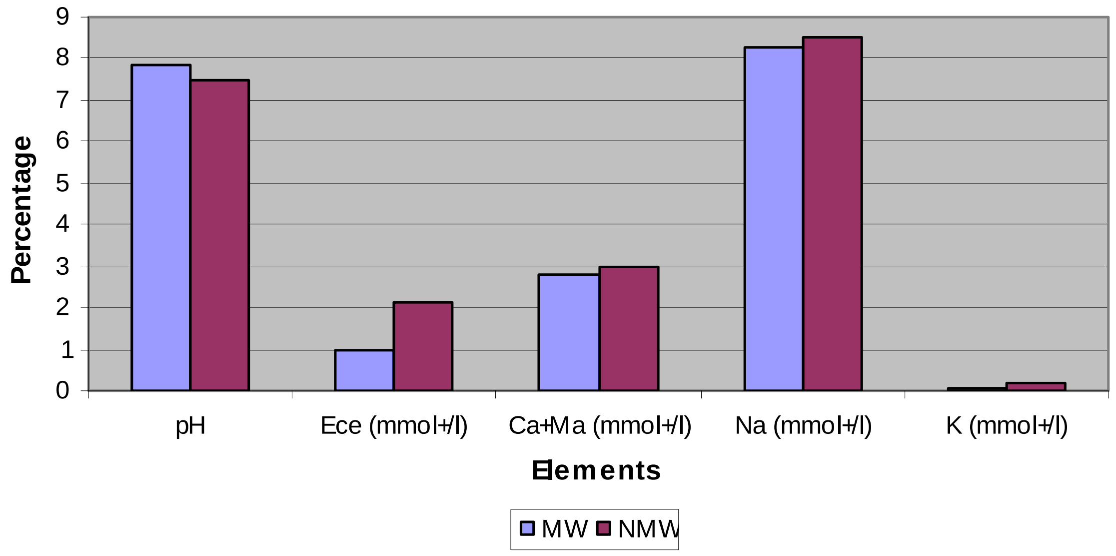


Fig:(15) Effect of magnetization on chemical composition of water.

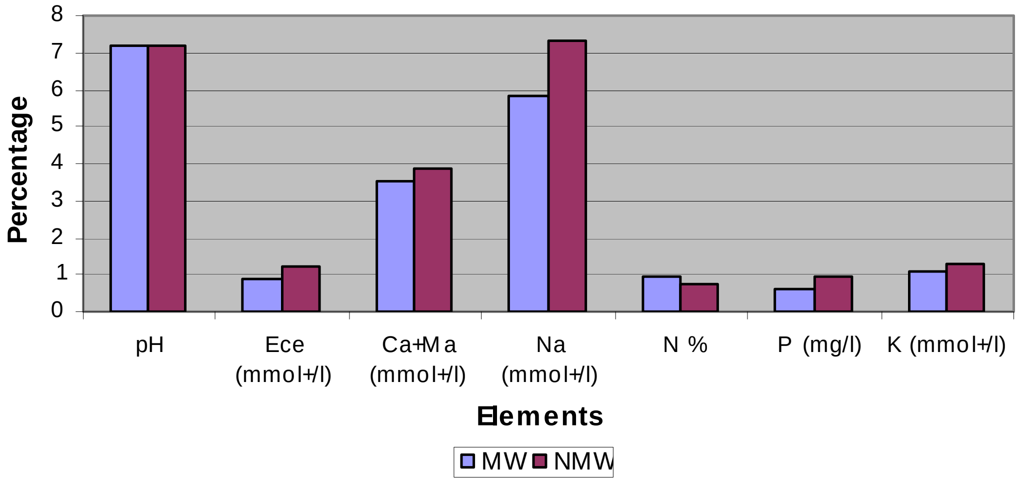


Fig:(16) Effect of MW and NMW on chemical composition of soil.

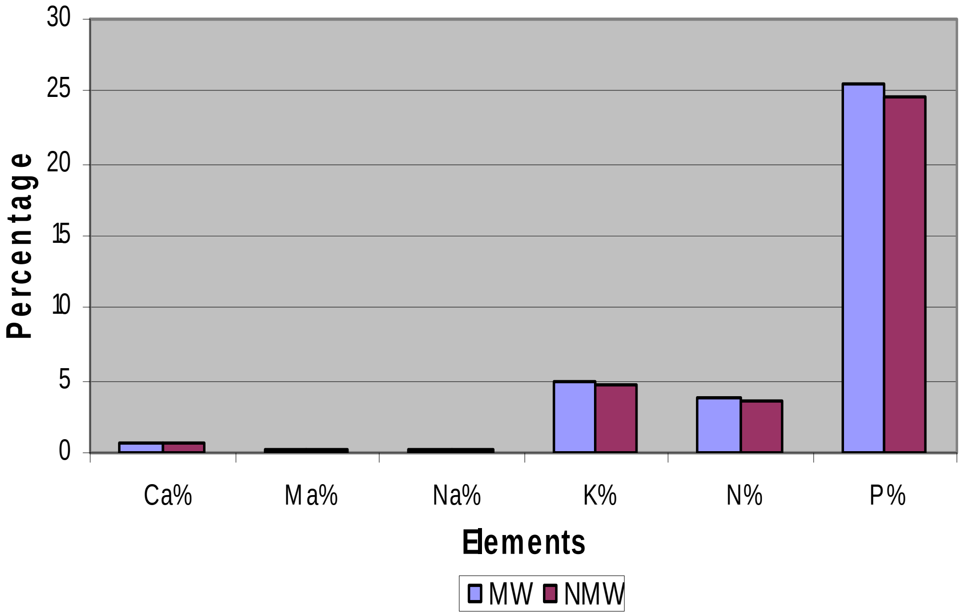


Fig:(17) Effect of MW and NMW on chemical composition of fruits

Plate (2) Preparation of beds and irrigation system, (mastaba and drib system).

Plate (3): Design of experiment and sowing of the seeds.

Plate (4) General view of the efficient in the cooled plastic tunnel.

Plate (5) Difference between MW and NMW plants.

Plate (6) Effect of doses of N and MW on flowering.

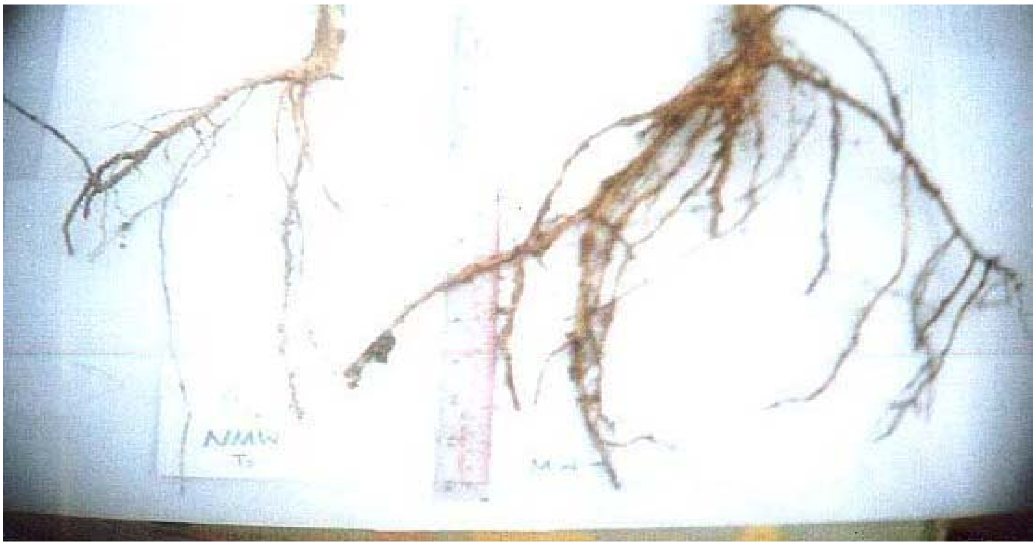
Plate (7). Effect of doses of N and NMW on flowering.

Plate (8). Effect of doses of N and NMW on fruit size.

Plate (9) Effect of doses of N and MW on fruit size.

Plate (10). Effect of doses of N and MW on fruit size.

Plate (11). Effect of doses of N and NMW on fruit size.



NMW MW

Plate (12) Effect of MW and MW on the roots.

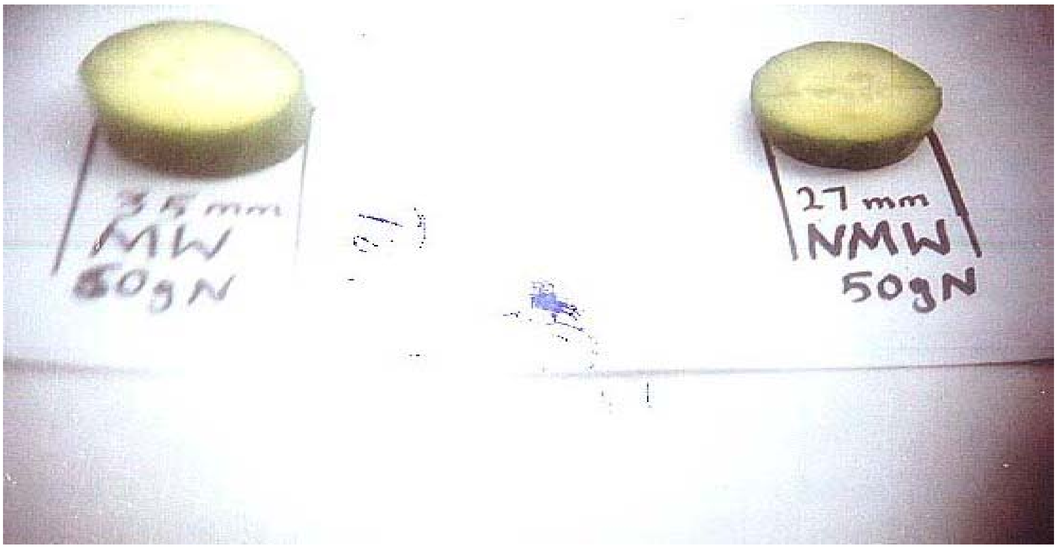


Plate (13) Effect of MW, NMW and N doses on fruit diameter.

Conclusions and Recommendations

From the previous results the following conclusions could be drawn:

1. There were significant differences between magnetized water and non-magnetized water in all parameters of growth and yield increasing by 12.1% with magnetized water. Also in the interaction between water and nitrogen there was a significant difference in all doses of nitrogen. It was found that the 40 grams nitrogen gave the highest means for magnetized water and non-magnetized water. So it is recommended that the suitable dose of nitrogen addition is 40 grams nitrogen per square meter under green house condition for cucumber cultivars.
2. There was increased of plant height, number of leaves and leaf area with magnetized water. So it is recommended to increase the space between plants.
3. Magnetized water gave the highest yield in two seasons, for number of fruits gave 49.7 fruits/m², for yield weight gave 6.1 kg/m².
4. The magnetized water had the highest acceptability compared with non- magnetized water at most of parameters which studied.
5. The magnetic irrigated fixed the nitrogen and at top of soil surface, and reduced all other elements.
6. With magnetized water it can reduce the seeds sawed for 50%.

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APPENDICES

Effect of MW, NMW and N on Plant height (cm) for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	357.2	357.4	358.3	359.2	363.2	356.5	352.5	357.5
NMW	330.6	343.9	346.5	343.6	347.9	342.6	342.9	342.7

Effect of MW, NMW and N on length of Internodes for two seasons

N	0	10	20	30	40	50	60	Mean
MW	12.7	13.7	14.3	13.8	14.7	12.8	12.2	13.5
NMW	12	13	13.3	13.5	14.2	12.7	12.2	13

Effect of MW, NMW and N on leaves Number/plant for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	125.9	125.8	128	129.5	131.9	129.4	126.7	128.2
NMW	118.5	120.2	120.7	123	1239	118.9	116.2	120.2

Effect of MW, NMW and N on Stem diameter (mm) for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	9.8	10.2	9.7	9.8	10.2	9.8	9.8	9.9
NMW	9.8	9.8	9.9	9.9	10	9.7	9.8	9.8

Effect of MW,NMW and N on number of flowers/plant for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	164.9	168.9	174.9	179.4	181.5	175.2	170.2	173.6
NMW	150.4	150.7	153.3	159	164.3	155.7	153.4	155.3

Effect of MW, NMW and N on leaf size (cm) for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	944.7	948.4	954	960.5	972.5	959.3	952.3	955.8
NMW	880.5	875.2	888.7	897.7	905.2	894.7	883.2	886

Effect of MW, NMW and N on length of fruits (cm) for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	14.9	15.7	15.8	16.3	17.6	15.2	14.8	15.8
NMW	14.2	14.7	14.9	15.5	15.9	15	14.6	15

Effect of MW, NMW and N on total soluble solid% for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	2.6	2.5	2.6	2.6	2.63	2.6	2.6	2.6
NMW	2.4	2.4	2.4	2.5	2.5	2.4	2.6	2.5

Effect of MW, NMW and N on fruits numbers/ m^2 for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	48.3	49	49.4	50	52.5	50.4	49.1	49.7
NMW	36.5	36.9	37.1	37.4	38.1	37.4	35.6	37

Effect of MW, NMW and N on weight of fruits kg/m^2 for two seasons.

N	0	10	20	30	40	50	60	Mean
MW	4.93	5.8	5.9	6.2	7.2	7.2	5.5	6.1
NMW	3.8	4	4.1	4.43	4.8	4.3	3.9	4.2

Effect of MW, NMW and N on Skin color and texture: two seasons.

Water	Skin	
	Color	Texture
MW	Dark-green	Smooth
NMW	Green	Smooth

Chemical composition of soil

Dose of nitrogen	0	10	20	30	40	50	60
pH	7.6	7.52	7.46	7.8	7.6	7.58	7.54
ECe	1.19	1.2	0.95	1.2	0.95	1.45	1.5
Ca + Mg%	3.5	3.65	3.7	3.65	3.58	3.56	3.7
Na%	6.5	6.3	6.45	6.58	6.5	6.24	6.35
K%	1.2	1.36	1.23	1.2	1.32	1.5	1.4
N%	0.7	0.78	0.76	0.76	0.85	0.75	0.78
P%	0.75	0.78	0.8	0.75	0.76	0.8	0.74

Chemical composition of fruits

Dose of nitrogen	0	10	20	30	40	50	60
Ca%	0.6	0.7	0.6	0.7	0.8	0.6	0.95
Mg%	0.24	0.3	0.2	0.2	0.64	0.24	0.33
Na%	0.2	0.21	0.14	0.2	0.22	0.2	0.2
K%	5.2	5.24	4.5	5	4.8	5.5	4.7
N%	3.6	2.4	3.4	4.1	4.1	4.3	3.7
P%	26.3	25.7	23.3	24.8	25.8	24.5	25.2

Humidity and temperature (First season)

Week Read	In			Out		
	Dry	Wet	Humidity %	Dry	Wet	Humidity %
W_1	26	21	63	37	26	40
W_2	27	22	63	34	25	47
W_3	26	22	70	36	23	31
W_4	25	21	69	36	21	23
W_5	24	19	60	35	20	21
W_6	21	17	66	35	19	17
W_7	21	18	74	34	19	20
W_8	24	21	76	34	19	20
W_9	22	14	37	33	19	23
W_{10}	24	19	60	32	19	25
W_{11}	25	19	55	32	20	30
Average	24	19	63	34	21	27

Humidity and temperature (Second season)

Week Read	In			Out		
	Dry	Wet	Humidity	Dry	Wet	Humidity
W_1	27	21	57	42	25	23
W_2	27	21	57	43	27	27
W_3	27	20	51	44	27	25
W_4	26	18	43	45	25	17
W_5	26	20	56	46	27	21
W_6	27	21	57	47	27	19
W_7	26	20	56	45	26	20
W_8	27	21	57	45	27	23
W_9	27	20	51	46	27	21
W_{10}	26	20	56	44	26	22
W_{11}	26	21	63	45	27	23
Average	27	20	55	45	26	22

Fungicide:-

No	Chemical name	Recommended dose	The dose	Method	Disease	Safe time
١	Tachigreen 30%SL	30ml/12L	60ml/24L	Irrigation or spray	Damping off	
٢	Vactomil +50	50g/35L	50g/35L	Irrigation	Damping off and powdering	10 days
٣	Vactomil plus 50	60g/40L	60g/40L	Irrigation	All fungi disease	10 days
٤	Radomil plus 42.5% WP	60g/40L	60g/40L	Irrigation	All fungi disease	10 days
٥	Thivot	60g/10L	120g/20L	Irrigation	All fungi disease	10 days

Acroicide:-

No	Chemical name	Recommended dose	The dose	Method	Pest	Disease	Safe time
١	Vertimic 1.8%	4ml/10L	8ml/20L	Spraying	Red across	Dry of leaver	7 days
٢	Mectin 1.8% EC	2.5ml/10L	5ml/20L	Spraying	Red across	Dry of leaver	7 days

Chemical for insecticide suitable for greenhouse.

No.	Chemical	Re dose	Dose GH	Method	Pest	PHI	Notice
١	Selecron 720 EC	0.24L/Fed	10ml/20L	Spraying	All chewing insect	7 days	
٢	Dorozban 1.8	0.24L/Fed	10ml/20L	Spraying	All chewing insect	7 days	
٣	Confidor 200	0.24L/Fed	10ml/20L	Spraying	All chewing insect	7 days	
٤	Betatol EC (Abamectin)	40cm3/Fed	8cm3/20L	Spraying	All chewing insect	7 days	
٥	Actara 25	240g/Fed	20g/20L	Spraying or irrigation	All chewing insect	7 days	By irrigation 20ml per plant
٦	Pflanzen schutzmttel	0.053L/Fed	10ml/20L	Spraying	All chewing insect	3 days	
7	Danitol – S 50EC	0.3L/Fed	50ml/20L	Spraying	All chewing insect and chewing larva	3 days	

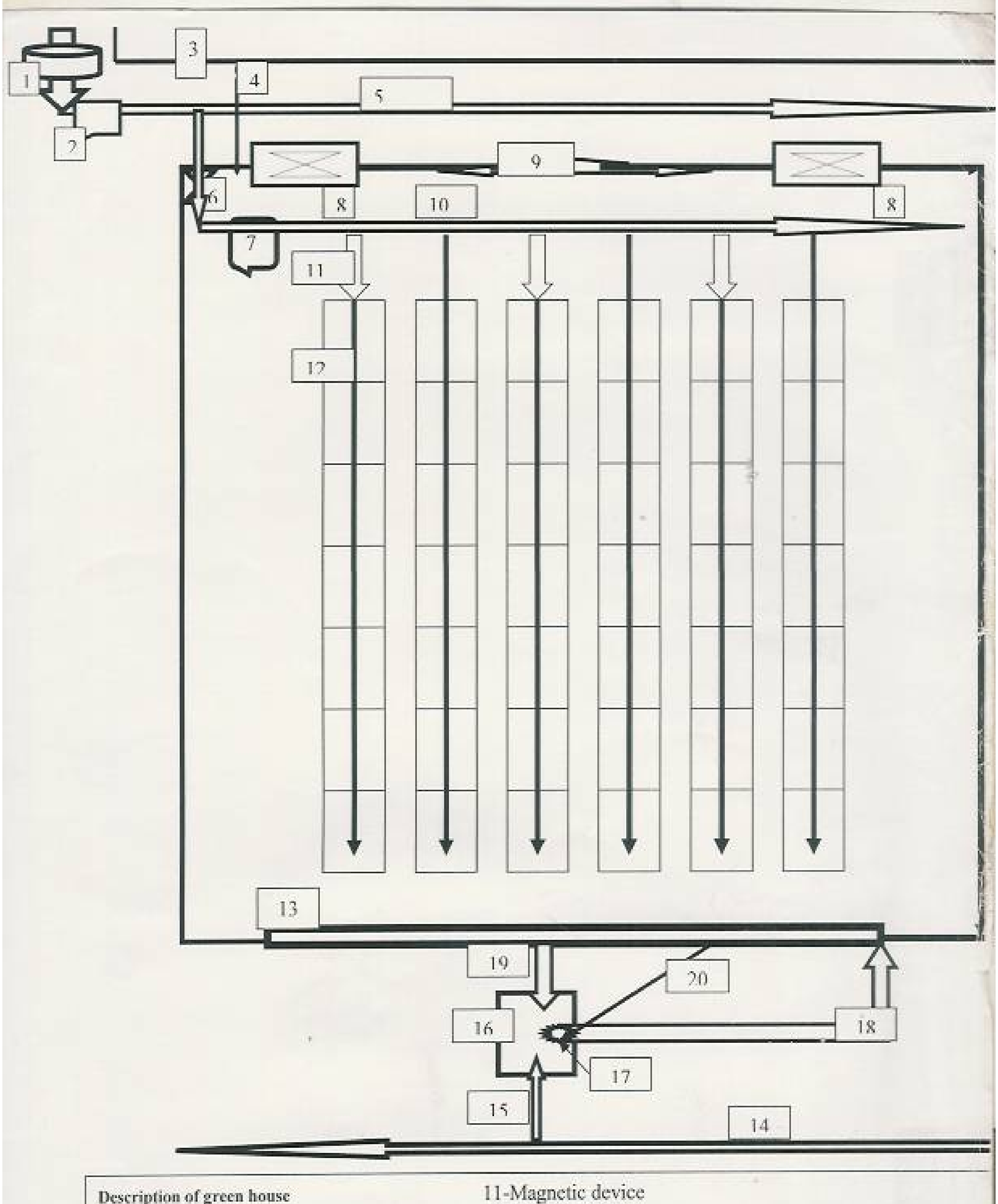
Spilt-plot design used

First season design

20	60	30	20	10	0
50	30	50	40	50	20
30	10	0	10	30	50
0	20	10	30	0	10
60	0	40	60	20	40
10	40	20	0	60	30
40	50	60	50	40	60

Second season design

50	0	10	40	20	10
60	10	0	20	60	30
20	40	20	30	10	50
40	20	50	50	40	0
10	60	40	60	0	40
30	50	30	10	30	20
0	30	60	0	50	60



Description of green house

- 1-Fertilition tank
- 2-Out side filter
- 3-Electric cable
- 4-Electric sub line
- 5- Irrigation main line (2)
- 6-Control valve
- 7-Inside filter
- 8-Shaft fan (L & R)
- 9- House door
- 10Sub main irrigation line (1)
- 11-Magnetic device
- 12- Drop line (16 mm)
- 13- Cool pad
- 14-Cool main line (2)
- 15- Sub main cool line
- 16-Tank cool water (1000 L)
- 17- Submersible single phase electric pump (400 W)
- 18- Feed line cooling (1)
- 19- Back feed line cooling (2)
- 20-Pump electric