An-Najah National University

Faculty of Graduate Studies

Evaluation of Yield and Energy Budget of Muskmelon Grown in Horizontal Hydroponic System under Different Nutrient Input

By

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This thesis was defended successfully on 5 / 5 / 2014 and approved by:

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Dedication

I dedicate this thesis to my father who has always been my nearest and has been so close to me that I wherever I need .

And to you, mother , thank you for your constant Empowerment . you are the most positive person I know . I love you both .

To my loved husband who has always been patient with me and gave me a great support from the beginning of this thesis .

To my children , for their patience and suffering .

To my dear brothers and sisters .

To science students in every time and place .

And I also dedicate this thesis to all who care about this .

Acknowledgements

All praise to Allah for this accomplishment .Then I send my sincere thanks and gratitude to my influential teacher, Prof.Dr. Marwan Haddad, who oversaw this letter and made a lot of effort which has had the greatest impact in the output of this message to come into the light.

And special thanks to my family , husband and children.

Finally I convey all the feelings of love and gratitude for all those who helped me and gave me the help in the completion of this study, perhaps beneficial to our institutions.

God grant success.

الإقرار

أنا الموقع/ة أدناه، الرسالة التي تحمل العنوان:

Evaluation of Yield and Energy Budget of Muskmelon Grown in Horizontal Hydroponic System under Different Nutrient Input

أُقرُّ بأنَّ ما اشتملت عليه هذه الرسالة، إنّما هي نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وإن هذه الرسالة كلّها ، أو أي جزء منها لم يقدم من قبل لنيل أية درجة، أو لقب علميّ، أو بحثيّ لدى أية مؤسسة تعليمية، أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: **اسم الطالبة :**

Signature: **التوقيع :**

Date: **التاريخ:**

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Evaluation of Yield and Energy Budget of Muskmelon Grown in Horizontal Hydroponic System under Different Nutrient Input

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Abstract

The current research aimed at evaluating yield and energy budget of muskmelon grown in horizontal hydroponic system under different nutrient input conducted in a greenhouse in the new An-Najah National University campus. The hydroponic system consisted of four rectangular metal canals (28 cm wide, 22 cm high, 27m long) filed with non-growing media. Muskmelon seedlings were planted in the hydroponic canals and fertigated with different nutrients (Nitrogen, Potassium and Phosphorus - NPK-) and salinity levels. The extents of nutrient and salinity uptake and impact on plant growth , yield and energy budget were evaluated for one growing season.

Experiment started in 26th of March, 2013 as follows:

- Three canals were filled with a nutrient solution containing: Nitrogen, Phosphorous and Potassium with different amount of concentration for each canal ((1/4) copper, (1) copper and (1) copper +1000 ppm salts (NaCl)) respectively.
- The fourth canal was used as a reference, so no additions were inserted.
- Fresh water was allowed to enter the system from a tank that filled the champers in each canal.

- Excessive water was discharged from the end of the canal to a drainage tank.

After the completion of the experiment, nutrient solution was stored at −20 ◦C for nutrient analysis. Ion nitrate was determined by the Kjeldahl method. Macronutrients (P and K) were measured directly and simultaneously from nutrient solution using emission spectrometry. Results were expressed as mg dry weight plant^{-1} day.$^{-1}$

Results for all nutrients used in the fertigation process indicated that:

1. Nitrogen percentage in stem and leaves had the largest percentage compared with roots and fruit, because nitrogen is concentrated in plant leaves. And it is observed that canal (2) had the largest value of nitrogen percentage compared with canals (1,3 and blank) .
2. Phosphorus concentrations in stem and leaves had the largest percentage compared with roots and fruit, because this element has a role in plant photosynthesis that concentrates phosphorus in plant leaves. It is observed that canal(2) had a large value of phosphorus in comparison with canals (1,3 and blank).
3. Potassium concentrations, roots had the large percent compared with (stem and leaves) and fruit, because these elements should be added to plant in the fruiting stage, for this reason adding more potassium before this stage or after it made potassium accumulate in roots .But it was observed that canal(2) had a large value for potassium compared with canals (1,3 and blank).

Results of total sugar for canals 1 and blank were approximately equal and differ from canal (2 and 3) that had larger percent of total sugar in the plant. This was due to large amounts of fertilizer added to these two canals (2 and 3).

Conductivity results indicated that stems and leaves had the largest conductivity value in the same canal while roots and fruits had the least value . But making a comparison between the four canals , canal 3 had the largest value, because (NaCl) salt was added to this canal**.**

As an outcome of this research it was concluded that:

1. Plant growth increased when Adding more fertilizer like canals 2 and 3 compared with canal 1and blank .
2. Energy budget increased when more fertilizer added to the plant like canals 2 and 3.
3. The presence of salt (NaCl) in canal (3) prevents plant from absorbing water and all nutrients from canal which leads to a decrease in plant productivity.

Chapter One

1. Introduction

Muskmelon (*Cucumismelo*) is an important horticultural crop that is grown throughout the world, mainly in Asia, America and Europe, with an overall production of 27.7 million tones and about 1.3 million hectares planted (FAOSTAT, 2011). Muskmelon is round, yellow-tan netted rind with salmon, white, or green flesh weighing about 2 to 3 pounds (0.9-1.3 kg). Very sweet taste and aromatically perfumed flesh. Sweet tasting and aromatic. (Albert ,2009).

Muskmelon is a perfect summer fruit. Its high water content can help in preventing the fluid loss that our bodies go through due to perspiration in this season. It also helps to combat the heat in the body and thus, prevents heat-related disorders during summer. If you are someone who is constantly counting calories then you should go the muskmelon way. This fruit is good for people who want to lose weight because it isn't high in calories or sugar, and can work as a great snack for those in-between-mealtimes when hunger tugs you towards unhealthy food items (Albert, 2009).

Muskmelon offers a decent dose of fiber, which helps in filling you up. As a snack for dieters, muskmelons can't be beaten. Muskmelon's juicy sweetness is a satisfying substitute for high-calorie snacks and desserts. The 2005 Dietary Guidelines for Americans recommend that most people eat 1.5 to 2 cups of fruit per day. Muskmelon is a great-tasting way to fulfill that recommendation (Amaro etal , 2012).

Muskmelon is rich in potassium, a nutrient that may help control blood pressure, regulate heartbeat, and possibly prevent strokes. The 2005 Dietary Guidelines state that a potassium-rich diet helps keep salt from raising blood pressure and may also reduce the risk of developing kidney stones and possibly age-related bone loss. The guidelines encourage adults to consume 4,700 milligrams per day (while keeping sodium to less than 2,300 milligrams per day, which is one teaspoon of salt) (Melo et al, 2000).

Muskmelons are also abundant in vitamin C, one arm of the now-famous disease-fighting antioxidant trio. Another arm that's well represented is beta-carotene. Researchers believe that beta-carotene and vitamin C are capable of preventing heart disease, cancer and other chronic conditions. No matter which way you slice them, when it comes to nutrition, muskmelons are a cut above (Ismail, 2010).

Muskmelon crop production in dry climates is particularly sensitive to deficiencies in soil moisture and N (Panagiotopoulos, 2001; Silva et al., 2007; Cabello et al., 2009).Nitrogen (N) is an important nutrient for muskmelon production. However, there is scanty information about the amount necessary to maintain an appropriate balance between growth and yield(Castellanos, 2011).The uptake of N and its accumulation in the parts of muskmelon plants over the growing season have been studied by researchers for some cultivar groups of muskmelon such as Reticulatus (Purqueiro et al., 2003; Kirnak et al., 2005), Cantalupensis (Pérez- Zamora and Cigales-Rivero, 2001; Fagan et al., 2006), and the results are different and sometimes contradictory. In most cases, these researchers show experiments located in greenhouses and in greenhouse hydroponics (Fukutoku et al., 2000; Fogaça et al., 2008). These authors gave information about the dynamics of N uptake but, in most cases, the optimum application rates were not determined.

Potassium is the second most abundant macro-nutrient element after nitrogen in terms of amounts found in plant tissues except seeds. Potassium (K), a well-known quality element, is involved in numerous biochemical and physiological processes vital to plant growth and quality. Insufficient or excessive potassium level adversely affects fruit quality, while adequate K nutrition is associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit color, increased shelf life, and shipping quality of many horticultural crops. However, potassium levels in previous nutrient solution culture studies varied considerably, and much confusion exists regarding the benefit of K fertilization due to different K forms utilized, soil vs. foliar applications, the environment (season), plus frequency of applications during fruit growth and development stages(Bidwell, 1974; Marschner, 1995).

Phosphorus is classified as a major nutrient, what means that it is frequently deficient for crop production and is required by crops in relatively large amounts. It is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next.(Zekri, 2009) .

Hydroponics is a method of growing plants in a soil-less environment. The nutrient source is provided directly to the plant roots in a solution. Jones in (1983) defines hydroponics as a nutrient solution delivery system which does not contain any organic or inorganic media for plant support.

Hydroponics minimizes problems such as clogged irrigation nozzles, cleaning of culture media between crops and allows for more precise control of the root zone environment (Yaakov et al,1983).

1.1 The Objectives of this Study were to determine:

- Evaluation of yield and sugar concentration of Muskmelon using different nutrient concentration and salinity in a hydroponic growing system.
- Determination of the nutrient removal capacity of the system and nutritional quality of muskmelon under hydroponic growing system.

1.2 Research Questions :

1- What are the quantitative amount of (NPK) fertilizer should be applied ?

2- What are the effects of excessive amount of irrigation on plant ?

3- How much does the growth of the plant become when we add the fertilizer ?

4- Does the fruit taste and sugar concentration changes during adding the fertilizer ?

5- What is the effect of adding salts on plant growth and sugar concentration ?

1.3 Motivations :

This research was carried out for many reasons such as:

1. This study has a relationship with the environment and the problem related to it during a little farmers' knowledge .
2. This study benefits many groups in Palestine .
3. This summer fruit all people like it .
4. This fruit has many benefits for the body .
5. To inform the farmers about the better condition for growing melon and the dosage of fertilizer that we should add .
6. Finally, no researchers in Palestine have addressed this topic .

1.4 Beneficiaries from the Research:

Several groups will benefit from this research:

1- Government ministries (Ministry of Agricultural ,Ministry of Environment, Ministries of Health and Palestinian Water Authority) that can develop many monitoring programs and legislations to help framers manage their agricultural activities to prevent and control water and excessive fertilizing .

2- Non-governmental organizations (NGOs): they can develop many monitoring programs to help framers manage their agricultural activities, and can fund and support many researches in these subjects.

3- Researchers who need previous studies and data about such theses topics can use it.

4- Farmers will recognize that the use of excessive fertilizers in uncontrolled ways, and the use of excessive water in irrigation have significant effect on plant growth and thus can affect human health so they can be careful and take more precautions when using fertilizers.

Chapter Tow

2. Literature Review

2.1 Muskmelon Identification

Muskmelon (*Cucumismelo*L.) is a commercially important crop in many countries. It is mostly cultivated in the temperate regions of the world due to its good adaptation to soil and climate. (Villanueva et al., 2004).

Muskmelon grow best in sandy, well-watered soil and in weed-free conditions. Fertilizer is the major cost in agriculture sector in the world. In fertigation system, the plants are fed by water including fertilizer by drip system in soilless media. Usually the fertilizer consumption on fertigation system is not specific to the optimal electrical conductivity (EC) but a certain range is used. There is a lack of information on the influence of the microbes and specific EC on fruit weight and fertilizer consumption in the appropriate dose of melon plant (Zulkarami et al., 2010).

Muskmelon are warm-season crops requiring a long growing season of 80 to 100 days from seed to fruit. Most present varieties are not well suited to small gardens because of the space requirement (Abend et al, 2010).

Muskmelons are well suited for growing on black plastic mulch. The black plastic absorbs heat readily, allowing the soil to warm quickly.(Virginia Polytechnic Institute and State University, 2009)

2.2 Muskmelon Distributions

Based on genetic studies, crossing attempts, and distribution, the origin of melon appears to be Africa. The division of *Cucumismelo* into ssp. *melo* and ssp. *agrestis* must have developed from wild muskmelons spread by man to Asia. The sweet wild melon found today is probably a result of domestication and cultivation as hybridization of muskmelon occurs frequently in nature (Kerje, 2000).

2.3 Muskmelon Nutrients

Plants require nitrogen in large amounts. Nitrogen promotes rapid growth, increases leaf size and quality, hastens crop maturity, and promotes fruit and seed development. Because nitrogen is a constituent of amino acids, which are required to synthesize proteins and other related compounds, it plays a role in almost all plant metabolic processes.Nitrogen is an integral part of chlorophyll manufacture through photosynthesis.(Photosynthesis is the process through which plants utilize light energy to convert atmospheric carbon dioxide into carbohydrates) (Tucker, 1999).

Nitrogen fertilizer is available in both organic (manures) and inorganic forms. Nitrogen-deficient plants exhibit slow stunted growth, and their foliage is pale green . Deficiency symptoms generally appear on the bottom leaves first. In severe cases , the lower leaves have a “fired” appearance on the tips, turn brown, usually disintegrate, and fall off (Barbara, 2011).Visual symptoms are seen first on older leaves as a yellowing (chlorosis) from the leaf tip and along the midrib, whilst the edges remain green. Because(N) is mobile in the plant, deficiency usually occurs first in older tissues. Distinct symptoms are not always obvious. The main effect of deficiency is retarded growth. Older leaves may turn yellow and eventually die back from tips and along margins (Better, 1999)

In contrast, too much nitrogen causes excessive vegetative growth, delays maturity, increases lodging, fosters disease and poses an environmental threat to surface and ground water. Fertilization with nitrogen is generally very prompt, depending on the source of nitrogen, stage of plant growth, rainfall and temperature (Johnson, 2012).

Normal plant growth cannot be achieved without phosphorus. It is a constituent of nucleic acids, phospholipids, the coenzymes DNA and NADP, and most importantly ATP. It activates coenzymes for amino acid production used in protein synthesis; it decomposes carbohydrates produced in photosynthesis; and it is involved in many other metabolic processes required for normal growth, such as photosynthesis, glycolysis, respiration, and fattyacid synthesis (Syunarti, 2008). It enhances seed germination and early growth, stimulates blooming, enhances bud set, aids in seed formation, hastens maturity and provides winter hardiness to crops planted in late fall and early spring (Rebafka,1993).

Phosphorus deficient plants are characterized by restricts root and top growth but appear normal. With more severe deficiency, the root system is poorly developed and stems are thin and erect with few branches and small, narrow leaves, stunted growth, dark green leaves with a leathery texture, and reddish purple leaf tips and margins. Symptoms usually occur on young plants when the soil temperature is below 60 F.

Deficiency symptoms may appear when soil phosphorus levels are adequate and When soil is cool. Phosphorus occurs in organic fertilizers (manures); inorganic blended fertilizers; and high phosphate materials such as mono-and diammonium phosphate ,triple superphosphate (Tucker, 1999).

Potassium has many functions in plant growth. It is essential for photosynthesis, activates enzymes to metabolize carbohydrates for the manufacture of amino acids and proteins, facilitates cell division and growth by helping to move starches and sugars between plant parts, adds stalk and stem stiffness, increases disease resistance, increases drought tolerance, regulates opening and closing of stomates, gives plumpness to grain and seed, improves firmness, texture, size and color of fruit crops and increases the oil content of oil crops (James, 2012).

The lowest amount of potassium is found in sandy coastal plain soils where it is subject to leaching. The higher concentrations are found in the clayey soils of the piedmont and mountain regions. High potassium is also found in areas where animal and poultry wastes have been applied. Potassium-deficient plants exhibit chlorosis (loss of green color) along the leaf margins or tips starting with the bottom leaves and progressing up the plant. In severe cases, the whole plant turns yellow, and the lower leaves fall off. As with other nutrients, lack of potassium causes stunted plants with small branches and little vigor (Tucker ,1999).

2.4 Specific Fertigation Application

2.4.1 Nitrogen Application

A study of nitrogen fertilisation levels to investigate the effect on fruit quality at harvest time and during storage. Experiments were performed in an open field using muskmelon plants . Nitrogen (N) was applied through fertigation using four fertilization levels. The results indicate that nitrogen increased yields by increasing fruits/plant, seeds/fruit and seed weight, had no effect on fruit weight, size and husk, and increased leaf area through leaf number and leaf size. (Ferrante, 2008) .

Another study evaluate the influence of different N amounts on the growth, production of dry matter and fruit yield of a melon 'Piel de sapo' type. Muskmelons were subjected to an irrigation depth of 100% crop evapotranspiration and to 11 N fertilization rates. The results showed that dry matter production of leaves and stems increased as the N amount increased. The dry matter of the whole plant was affected similarly, while the fruit dry matter decreased as the N amount was increased. Excessive applications of N increase vegetative growth at the expense of reproductive growth (Panagiotopoulos, 2001; Silva et al., 2007; Cabello et al., 2009).

A study on maize (Zea mays L.) in southern Nigeria was evaluated. It showed that application of nitrogen and phosphorus fertilizers increases growth and grain yield in maize production (Onasanya ,2009).

Field studies were conducted at the Teaching and Research farm, to determine the individual and combined levels of nitrogen (N) and phosphorus (P) fertilizers required for optimum growth and seed yield of muskmelon which subjected to 4 levels of N and 4 levels of P in order to investigate the main and interactive effects of N and P. The results showed that various levels of individual and combined N and P fertilizers significantly (P # 0.05) influenced the growth and seed yield of muskmelon (Olaniyi, 2008).

2.4.2 Phosphorus Application

Phosphorus (P) is vital to plant growth and is found in every living plant cell. It is involved in several key plant functions, including energy transfer, photosynthesis ,transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next **(**Better, 1999).

2.4.3 Potassium Application

Potassium is second to nitrogen in plant tissue levels with ranges of 1 to 3% by weight .Potassium is the only essential plant nutrient that is not a constituent of any plant part. Potassium is a key nutrient in the plants tolerance to stresses such as cold/hot temperatures, drought, wear and pest problems. Potassium acts as catalysts for many of the enzymatic processes in the plant that are necessary for plant growth to take place (Ashley and Grabov, 2006).

Another key role of potassium is the regulation of water use in the plant(osmoregulation). This osmoregulation process affects water transport in the xylem,maintains high daily cell turgor pressure which affects wear tolerance, affects cell elongation for growth and most importantly it regulates the opening and closing of the stomates which affect transpirational cooling and carbon dioxide uptake for photosynthesis (James, 2012).

Potassium uptake is most rapid on warm, moist soils that are well aerated and have a slightly acidic to neutral pH. As soil temperature increases, plant metabolic activity increases which in turn increases root growth and root activity. Warmer soil temperatures also increase the diffusion rate of potassium in the soil solution which increases potassium uptake by the root system. Excess soil moisture can lower soil oxygen levels which in turn decrease the respiration rate for the plants root system and thus lowers potassium uptake (Schalau, 2008).

A field study was conducted to determine the response of cowpea to potassium fertilizer treatment in three levels 0 , 33.75 , 67.50 kg K ha-1. Results had shown that the potassium fertilizer treatment in 33.75 (kg K ha-1) level has significant increase in plant weight , pods number and the yield of plant. (Bidwell, 1974 ; Marschner, 1995).

2.5 Total Dissolved Solid (SALT).

Muskmelon is a crop with high potential in arid and semi arid areas having salinity problems (Botia et al, 2005).Generally, although muskmelon is known to be moderately tolerant to salinity, it has been reported that salt tolerance in muskmelons depends on the cultivars and there are sensitive cultivars as well as tolerant ones (Kuşvuran et al, 2007).

Astudy was carried out in hydroponic conditions in growth chamber using salt tolerant. Plants were subjected to 100 mMNaCl for 12 days. Fresh and dry weights were decreased by salinity. (Kaya et al, 2007; Tavakkoli et al, 2011).

Another study about tolerance to stress conditions for stomatal and leaf characteristics of 14 hybrid genotypes. The results revealed that in saline condition, the number of stomata in unit area increased; however, the size of stomata decreased. Also leaf area, width and length were decreased when compared to control (Hakan, 2011).

2.6 Muskmelon Planting Under Hydroponic System

Hydroponics is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions, in water without soil.

Researchers discovered in the 18^{th} century that plants absorb the essential mineral nutrients as inorganic ions in water. In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. Almost any terrestrial plant will grow with hydroponics. Hydroponics is also a standard technique in biology research and teaching (Joe, 1974).

The earliest published work on growing terrestrial plants without soil was the (1627 book *Sylva Sylvarum* by Francis Bacon), printed a year after his death. Water culture became a popular research technique after that. In 1699, John Woodward published his water culture experiments with spearmint. Solution culture is now considered a type of hydroponics where there is no inert medium (Stout, 1966).

In 1929, William Frederick Gericke of the University of California at Berkeley began publicly promoting that solution culture would be used for agricultural crop production. He first termed it aquaculture but later found that aquaculture was already applied to culture of aquatic organisms. (Gericke, 1929).

Reports of Gericke's work and his claims that hydroponics would revolutionize plant agriculture prompted a huge number of requests for further information. Gericke refused to reveal his secrets claiming he had done the work at home on his own time. This refusal eventually resulted in leaving the University of California. In 1940, he wrote the book, *(Complete Guide to Soilless Gardening)*.(Gericke, 1940).

One of the early successes of hydroponics occurred on Wake Island, a rocky atoll in the Pacific Ocean used as a refueling stop for Pan American Airlines. Hydroponics was used there in the 1930s to grow vegetables for the passengers. Hydroponics was a necessity on Wake Island because there was no soil, and it was prohibitively expensive to airlift in fresh vegetables (Gericke, 1940).

This system has many Advantages and Disadvantages :

1. All plants require water. The amount they use depends on how much energy (sunlight) is available to cause them to evaporate water, as well as the amount of water supply available to the roots.
2. A major function of a hydroponic system's is to provide freely available water to the root system. This cannot be done as easily as in soils because too much water will cut off the oxygen supply, which kills the roots . As soils dry out between irrigations, some stress is unavoidable . Maximum amounts of water can be supplied in the usual types of hydroponic mixtures because pore space is large and their water holding capacity is usually low.
3. All the necessary elements for growth can theoretically be provided in correct amounts. In practice, it is difficult to supply a constant ratio and concentration of essential elements without expensive analyticalequipment. It is desirable to make some provision for adding small amounts of elements to replace those exhausted by the plants during growth. It is also difficult to supply plant requirements as to

correct element ratios, acidity, and tolerance to salts, because these vary with light, water, temperature, and other factors.(Hoagland, 1950).

4. Not all plants require the same environment. For example, the greenhouse environment for roses is deliberately manipulated to reduce water requirements .The response of commercial roses grown directly in gravel is usually comparable to roses grown directly in good soil.In many regions of the world, hydroponics may be utilized because there is no soil or the available soil is unsuitable.
5. If the water supply has high sodium ,hydroponics may be the only acceptable system since excessive sodium causes soil structure to break down and lose its desirable characteristics. Obviously, hydroponics may be the only practical solution in space flights or for moon inhabitants.
6. In the final analysis, under suitable climatic conditions, and with all other factors being equal, hydroponics may offer a 20 to 30 percent yield increase over comparable soil culture. The important point to keep in mind is that good soil will usually forgive most mistakes while hydroponics systems will not .For instance root media will be un buffered, too much fertilizer can easily burn the plants, and neglected watering systems may damage plants and spread disease (Joe, 1974).

2.7 Summary

Muskmelon are warm-season crops requiring a long growing season of 80 to 100 days from seed to fruit. It is mostly cultivated in the temperate regions of the world due to its good adaptation to soil and climate. muskmelons grow best in sandy, well-watered soil and in weed-free conditions. Muskmelon are well suited for growing on black plastic mulch. The black plastic absorbs heat readily, allowing the soil to warm quickly. The origin of muskmelon appears to be Africa.

Muskmelon require nitrogen in largest amounts, which promotes rapid growth ,increases leaf size and quality, hastens crop maturity, and promotes fruit and seed development ,Because nitrogen is a constituent of amino acids, which are required to synthesize proteins and other related compounds, it plays a role in almost all plant metabolic processes and it is an integral part of chlorophyll manufacture through photosynthesis .

Phosphorus requires normal plant growth, because it is a constituent of nucleic acids, phospholipids, the coenzymes DNA and NADP, and most importantly ATP. It activates coenzymes for amino acid production used in protein synthesis; it decomposes carbohydrates produced in photosynthesis; and it is involved in many other metabolic processes required for normal growth, such as photosynthesis, glycolysis, respiration, and fatty acid synthesis. It enhances seed germination and early growth, stimulates blooming, enhances bud set, aids in seed formation, hastens maturity and provides winter hardiness to crops planted in late fall and early spring .

Potassium is essential for photosynthesis, activates enzymes to metabolize carbohydrates for the manufacture of amino acids and proteins, facilitates cell division and growth by helping to move starches and sugars between plant parts, adds stalk and stem stiffness, increases disease resistance, increases drought tolerance, regulates opening and closing of stomata's, gives plumpness to grain and seed, improves firmness, texture, size and color of fruit crops and increases the oil content of oil crops.

Many works investigate the effect of fertilization nutrients (NPK) on the plant growth, production of dry matter and fruit yield of a muskmelon and reach to the result that fertilization increased yields by increasing fruits/plant, seeds/fruit and seed weight.

Studies which used to determine the effect of salinity on plant growth , stomata and leaf characteristics indicated that, fresh and dry weights decreased by salinity, number of stomata in unit area increased; whereas, the size of stomata decreased, also leaf area, width and length decreased.

Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil .The word "hydroponics" was coined many years ago to describe plant culture in inert soils where nutrients and water are supplied from storage tanks, saved, and recalculated as needed.

2.8 Why this Research is Needed ?

This research has addressed an important horticultural growth aspects of an economic and food crop in Palestine: muskmelon . Previous studies about muskmelon varied considerably and much variability existed in obtained results .

This research is needed due to the following reasons:

1. Few studies about muskmelon and nutrient in Palestine compared to other plants .
2. There was no research for studying the effect of these three elements (NPK) together and salt tolerant .

3. The previous studies determine the effect of nutrient on plant and yield but no studies have determined the optimum rate of these nutrients to obtain a large yield with good quality.
4. The uptake of N and its accumulation in the parts of muskmelon plants over the growing season have been studied by researchers , but results are different and sometimes contradictory.
5. Researchers gave information about the dynamics of N uptake but, in most cases , the optimum application rates were not determined .
6. Potassium levels in previous nutrient solution culture studies varied considerably, and much confusion regarding the benefit of K fertilization due to different K forms exists.

Chapter Three

3. Materials and Methods

3.1 Experimental Set Up

This study was carried out during 2013/2014 academic year in a hydroponic system existing in water and environmental studies at An-Najah National University**.**

The experiment set up consisted of the following :

1. Water-feed system : Fresh water was allowed to enter the system from a tank that fills the champers in each canal.
2. Hydroponic canals: each canal is 27m long 28 cm wide and 22 cm high, with three chambers filled with water and fertilizer(Fig.1), three canals were filled with a nutrient solution containing: Nitrogen ,Phosphorous and Potassium, the fourth canal was used as a reference, so no additions were inserted.
3. Drainage system :Excessive water was discharged from the end of the canal .

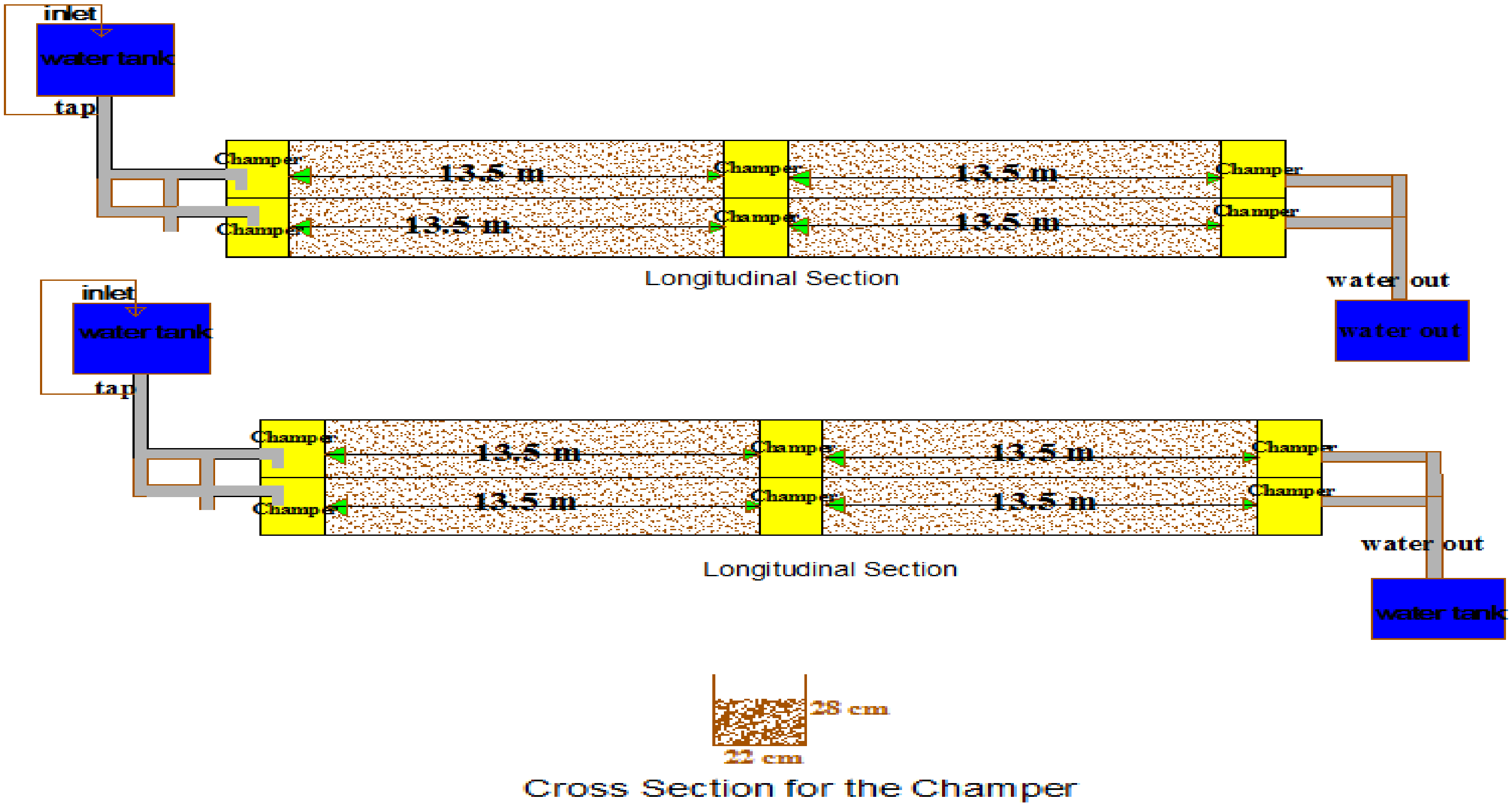

Fig.1 (The hydroponic system).

3.2Experimental program

3.2.1 Muskmelon Plants

Seedling of muskmelon was planted in 26th of march,2013 in four canals used 210 seedlings (Fig.2) to be evaluated in this study. This seedling when planted was (6-7) cm in height with (3-4) leaves and we planted it in the canal of the hydroponic system ,we put (52-53) seedling for each canal and the space between one seedling and the others is 50 cm.

Fig.2 (seedling of muskmelon in hydroponic canals).

3.2.2 Hydroponic experiment

The efficiency of hydroponic system with specific nutrients was evaluated to optimize yield and quantify nutritive value at different maturity stages .Three canal will be filled with a nutrient solution containing: Nitrogen ,Phosphorous and Potassium.Adding fertilizer started at 28th of April ,2013.But before this date ,the change in height , leaves number and fruit number per week were recorded to compare these numbers with the number when adding fertilizer(Fig.3).

Fig.3 (Seedling in hydroponic canals after adding fertilizer).

There were four canals which filled with nutrients solutions : 1/4 copper (copper is a fertigation system that was chosen) was added to the first canal (Table.1) shows the amount of nutrients in mg/l) of (NPK) which equals 45.3222g , 12.474g, 62.37g respectively. The following materials were added to the second canal: 1 copper of (NPK) which equals in gram 181.2888g , 49.896g , 249.480g in order . Same amount of (NPK) was added to the third canal with a difference by adding (1000ppm)of sodium chloride (NaCl) which equals (20g) of this salt .The fourth canal was blank where no fertilizers were added to it. Each plant separated into root and aerial parts(stem, leaves and fruit) to determine fresh and dry weights.

Table .1: The amount of Nutrients Per Canal

The canal	Copper (mg/l)	Nitrogen (218mg/l)	Phosphorus (60mg/l)	Potassium (300mg/l)
The first canal	1/4copper	45.3222g/l	12.474g/l	62.37g/l
The second canal	1 copper	181.2888g/l	49.896g/l	249.480g/l
The third canal	1copper +NaCl	181.2888g/l +20g	49.896g/l	249.480g/l
The fourth canal	Blank	0	0	0

3.2.3 Nutrient absorption in pot experiment

Nutrient solution were stored at −20 ◦C for nutrient analysis. Ion nitrate was determined by the Kjeldahl method (Bremner, 1965).The following were the procedures :

1. Samples preparations : (1g)of each sample from root parts & aerial parts (stem , leaves and fruit) was taken, after burning them in an oven at 550 C for 8 hours.
2. Digestion procedure : (2) kjeltabs (Cu 3.5) and 15 ml of concentrated H2SO4 were added to the burning samples and shook gently to wet the sample , then put in aspirator to digest for 60 minutes . Then the rack with exhaust was removed and left to cool for 15 minutes .
3. Distillation procedure : dilute cooled digest and put them in a flask to add to them 50 ml Boric acid , then 50 ml (40% Na OH) were added to dilute digest waiting to allow the reaction to settle (delay) and making titration with standardized titrant (0.05N).
4. Calculation : % Nitrogen =(T-B)*14.007 *N*100/Weight of sample after drying (mg).

T=Sample titration , B =Blank titration , N=Normality of titrate .

Macronutrients (P and K) measuring them directly and simultaneously from nutrient solution using emission spectrometry. Results were expressed as mg dry weight plant^{-1} day^{-1}. Potassium was determined by following these procedures :

1. Samples preparations : (1g) of sample from roots parts and aerial parts (stem , leaves and fruit)were taken after burning the sample in an oven at 550 C for 8 hours .
2. Dilution : 250 ml of distilled water was added and shake them gently , and waiting for settling .
3. Filtration : making filtration for each sample by filter papers,to take the solution without any impurities .
4. Flamephotometer : Flamephotometer was used for each solution obtained from step 3 , to used the number that appear in the calculation to measure the % of potassium in each sample.
5. Calculations : this equation was used to make the calculations :

   K (ppm)= the number that appear in the flamephotometer *volume total (250ml)/weight before drying *10000 Measurement the other macronutrient phosphorus (p) by following these procedures :

1. Samples preparations : (1g) of sample from root parts and aerial parts (stem , leaves and fruit)were taken after burning the sample in an oven at 550 C for 8 hours .
2. Dilution : 250 ml distilled water was added and shake them gently ,and added 3 ml H2SO4 and amount of (NaOH) to adjust the PH=5.0 .
3. Filtration : making filtration for each sample by filter papers, to take the ashes that settle in the filter paper and complete the volume to 250 ml by adding Distilled Water.
4. Reagent Preparation :Combined ascorbic reagent was added to 5 ml of the solution, the developed blue color was read at (880)nm (Manual

laboratory analysis for soil and plant ,Jon Rayen, et al 2003). The combined ascorbic reagent contains Ammonium molybdate , antimony potassium tartrate, sulfuric acid and ascorbic solution.

5. Standard Preparation : Stock phosphorus standard solution was prepared from Potassium phosphate monobasic (KH_2PO_4), nine standard phosphorus concentrations were prepared from stock solution and treated as same as the samples. These nine concentrations were used to plot absorbance versus phosphate concentration to give a straight line ,and they were: 0.4, 0.6, 0.8, 1.0, 2.0, 3.0, 4.0, 6.0, and 8.0 ppm .
6. Spectrophotometric Determination: 5 ml from the sample in the step 3 were taken , and 4 ml from the reagent were added to it and the volume was increased to 25 ml by distilled water to detect the absorbance for each dilution at which wavelength it read max (880nm).after that different concentrations with a different volume were taken from standard and added to 4 ml from reagent to increase the volume to 25 ml by distilled water , to detect the absorbance for each dilution to make a calibration curve.
7. Calculation : The following equation was used :

   phosphorus concentration(p%)= 0.225 X , X =sample absorption .

3.2.4 Measurement conductivity

Six random samples from each canal were taken and separated to three parts: root, (stem and leaves) and fruit. Then, the samples were dried in an oven at 105 C for 2 hours .After that, 5 grams from each sample were taken and 50 ml of distilled water were added to them and tested in an electrical conductivity meter .The following equation was used to measure the conductivity:

Conductivity (μs/cm)= the number that appears in electrical conductivity meter *weight before drying g / 50 ml .

3.2.5 Yield evaluation and energy budget

Mature muskmelons fruits (Fig.4) were evaluated after being harvested and weighed from five random plants for each canal as kg fruit plant^{-1}.

Fig .4 (mature muskmelon).

3.2.6 Nutritional quality

10 ml were taken from the center of the fruit to make 20 samples.

The samples were tested with five random plants for each canal to determine total Sugar concentrations with a hand-held refractometer**.**

Chapter Four

4. Results and Discussion

Results of muskmelon were taken after a week of plantation to observe the growth of plant by measuring the height, number of leaves and number of fruits for each plant and for five weeks; three weeks before adding nutrient and two weeks after adding nutrient .Then Mature muskmelon fruits were harvested and weighed, total yield were evaluated as kg fruit plant^{-1}for determining the yield .After that Sugar concentrations from samples were taken from the centre of the fruit and determined with a hand-held refractometer to measure the energy budget of the plant . Ion nitrate was determined by the Kjeldahl method (Bremner, 1965) for both the aerial parts of plants and the roots .Results of Macronutrients (P and K) were measured directly and simultaneously from nutrient solution using emission spectrometry .Finally; results about muskmelon uptake of salt (total dissolved solid) were measured and recorded using the electrical conductivity meter .

4.1 Growth of Muskmelon

From Table.(2,3,4,5) plants height, number of leaves and number of fruit increased continuously from week (1) , (2) to week (3) before adding the fertilizer. The height and the number of leaves in the same week for the same canal increased with the distance due to some reasons :1.the distance between the plant was more adjacent to the other in the beginning of the canal compared with others in the middle and in the end of the canal .2.

The slope of the canal makes the plant in the beginning of the canal had less opportunity to obtain water like the plants in the rest of the canal.

Table.2: (Height ,No. of leaves and No. of fruits before fertigation for canal 1).

Distance (m)	Height (cm)			No. of Leaves			No. of Fruits		
	Week1	Week2	Week3	Week1	Week2	Week3	Week1	Week2	Week3
5	12.7	31.9	44.6	8.6	17.5	23.8	0	0	1
10	13.9	34.7	46.1	10.5	17.3	24.7	0	0	1
15	15	36.6	47.7	11.1	20.3	28	0	0	1
20	14.9	34.6	47.7	12.4	20.6	20.8	0	0	0
25	16.2	37.7	48.7	14.4	19.3	33	0	0	1

Regarding the Height, before Fertigation in canal (1) table (2) shows that total height of the plant was least in the first week reached (12.7) on distance of (5 meters) and the total height of the plant highest in the first week was (16.2) on distance (25 meters), the highest reading for plant height with total height was (48.7) in the third week, on distance (25 meters).

Regarding the number of leaves of the plant before Fertigation in canal (1) Table (2) shows that the total number of leaves of the plant was least in the first week where it reached (8.6) on distance of (5 meters) and the total number of leaves of the plant highest in the first week was (14.4) on distance (25 meters), the highest reading for number Leaves of the plant with total was (33) in the third week, on distance (25 meters).

Regarding the number of Fruit before Fertigation in canal (1) table (2) showed that there was one fruit on the plant in the third week on distances (5.10, 15, 25) meters, but there's no Fruit on the Plant on Distance (20).

Table .3: (Height, No. of leaves and No. of fruits before fertigation for canal 2)

Distance (m)	Height(cm)			No. of Leaves			No. of Fruits		
	Week1	Week2	Week3	Week1	Week2	Week3	Week1	Week2	Week3
5	12.6	31.9	46.9	10.5	22.2	29.8	0	0	1
10	13.6	43.1	46.7	13.2	28.2	38.4	0	0	1
15	16.6	36	49.2	16.1	33.1	42	0	0	1
20	15.2	36	47	14.6	30.6	39.5	0	0	1
25	15.3	35.9	46.3	15.2	31.6	41.2	0	0	1

Regarding the Height, before Fertigation in canal (2) table (3) showed that total Height of the plant was least in the first week reached (12.6) on distance of (5 meters) and the total Height of the plant highest in the first week was (16.6) on distance (15 meters), the highest reading for plant height with total Height was (49.2) in the third week, on distance (15 meters).

Regarding the number of leaves of the Plant before Fertigation in canal (2) table (3) showed that total number of Leaves of the plant was least in the first week reached (10.5) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (16.1) on distance (15 meters), the highest reading for number Leaves of the plant with total was (42) in the third week, on distance (15 meters).

Regarding the number of Fruit before Fertigation in canal (2) table (3) showed that there was one fruit on all plant in the third week on distances (5.10, 15, 20, and25) meters.

Table.4: (Height ,No. of leaves and No. of fruits before fertigation for canal 3).

Distance (m)	Height (cm)			No. of Leaves			No. of Fruits		
	Week1	Week2	Week3	Week1	Week2	Week3	Week1	Week2	Week3
5	13	33.8	47.1	10.7	18.9	26.7	0	0	1
10	13.9	35.6	47.6	14.1	25.9	33.7	0	0	1
15	13.3	33.9	47.2	13.7	25.6	35.1	0	0	1
20	14.3	35	47.7	13.1	26.7	38.5	0	0	1
25	16.3	37.6	50	13.7	27.4	39.8	0	0	1

Regarding the Height, before Fertigation in canal (3) table (4) showed that total Height of the plant was least in the first week reached (13) on distance of (5 meters) and the total Height of the plant highest in the first week was (16.3) on distance (25 meters), the highest reading for plant height with total Height was (50) in the third week, on distance (25 meters).

Regarding the number of leaves of the Plant before Fertigation in canal (3) table (4) showed that total number of Leaves of the plant was least in the first week reached (10.7) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (14.1) on distance (10 meters), the highest reading for number Leaves of the plant with total was (39.8) in the third week, on distance (25 meters).

Regarding the number of Fruit before Fertigation in canal (3) table (4) showed that there was one fruit on all plant in the third week on distances (5.10, 15, 20, 25) meters.

Table .5: (Height ,No. of leaves and No. of fruits before fertigation for canal 4).

Distance (m)	Height (cm)			No. of Leaves			No. of Fruits		
	Week1	Week2	Week3	Week1	Week2	Week3	Week1	Week2	Week3
5	12.8	31.7	44.2	8.8	17.5	24.8	0	0	1
10	13.8	34.5	45.1	9.5	17.5	23.7	0	0	1
15	14.9	36.6	46.7	10.1	18.3	25.2	0	0	1
20	14.9	35.6	47.2	11.4	19.6	21.8	0	0	0
25	16	36.7	47.7	12.4	19.2	26.7	0	0	1

Regarding the Height, before Fertigation in canal (4) table (5) showed that total Height of the plant was least in the first week reached (12.8) on distance of (5 meters) and the total Height of the plant highest in the first week was (16) on distance (25 meters), the highest reading for plant height with total Height was (47.7) in the third week, on distance (25 meters).

Regarding the number of leaves of the Plant before Fertigation in canal (4) table (5) showed that total number of Leaves of the plant was least in the first week reached (8.8) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (12.4) on distance (25 meters), the highest reading for number Leaves of the plant with total was (26.7) in the third week, on distance (25 meters).

Regarding the number of Fruit before Fertigation in canal (4) table (5) showed that there was one fruit on the plant in the third week on distances (5.10, 15, 25) meters, but there's no Fruit on the Plant on Distance (20).

From Table.(6,7,8,9) plants height, number of leaves and number of fruit increase continuously from week (1) to week (2) and compared with other plants before adding fertilizer , but the difference appeared from the beginning of the canal to the end due to the same reason that concentrates the water and fertilizer away from the beginning. But the reason for increasing the length of the plant at a rate of more than the number of leaves was that, this period of growth was the length of the night more than a day and thus a period of a few lighting so the plant is trying to move towards the light and the increase in longitudinal growth.

Table.6: (Height ,No. of leaves and No. of fruits after fertigation for canal 1).

Distance (m)	Height(cm)		No. of Leaves		No. of Fruits	
	Week1	Week2	Week1	Week2	Week1	Week2
5	35.8	97.1	46.5	67	1	2
10	60.3	101.1	48.8	70.2	1	1
15	61.9	102.3	50	71.4	1	2
20	61.1	101.1	49.1	70.6	1	1
25	61.6	102.4	50.2	72.2	1	2

Regarding the Height, after Fertigation in canal (1) table (6) shows that total Height of the plant was least in the first week reached (35.8) on distance of (5 meters) and the total Height of the plant highest in the first week was (61.9) on distance (15 meters), the highest reading for plant height with total Height was (102.4) in the Second week, on distance (25 meters).

Regarding the number of leaves of the Plant after Fertigation in canal (1) table (6) showed that total number of Leaves of the plant was least in the first week reached (46.5) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (50.2) on distance (25 meters), the highest reading for number Leaves of the plant with total was (72.2) in the second week, on distance (25 meters).

Regarding the number of Fruit afterFertigation in canal (1) table (6) showed that there was one fruit on the plant in the first week on distances (5.10, 15, 20 and 25) meters, and there were (2) fruits on the plant in the Second week on distances (5, 15, and 25) meters, while it remained one fruit in the second week on distances (10 and 20) meters.

Table.7: (Height ,No. of leaves and No. of fruits after fertigation for canal 2).

Distance (m)	Height(cm)		No. of Leaves		No. of Fruits	
	Week1	Week2	Week1	Week2	Week1	Week2
5	62.6	124.4	52.2	65	1	1
10	67.4	129.8	55.2	72	1	1
15	72.5	134.2	58	75	1	1
20	70.1	133.1	59.3	76.8	1	1
25	72.3	136	62.3	81.5	1	1

Regarding the Height, after Fertigation in canal (2) table (7) shows that total Height of the plant was least in the first week reached (62.6) on distance of (5 meters) and the total Height of the plant highest in the first week was (72.5) on distance (15 meters), the highest reading for plant height with total Height was (136) in the Second week, on distance (25 meters).

Regarding the number of leaves of the Plant after Fertigation in canal (2) table (7) showed that total number of Leaves of the plant was least in the first week reached (52.2) on distance of (25 meters) and the total number of Leaves of the plant Highest in the first week was (62.3) on distance (25 meters), the highest reading for number Leaves of the plant with total was (81.5) in the second week, on distance (25 meters).

Regarding the number of Fruit after Fertigation in canal (2) table (7) showed that there was one fruit on the plant in the first week on distances (5.10, 15, 20 and 25) meters, while it remained one fruit in the second week on all distances.

Table.8: (Height ,No.of leaves and No.of fruits after fertigation for canal 3).

Distance (m)	Height(cm)		No. of Leaves		No. of Fruits	
	Week1	Week2	Week1	Week2	Week1	Week2
5	68.2	138.3	57.8	69.2	1	1
10	68.8	138.4	58.7	69.4	1	1
15	68.7	138.5	58.8	71.5	1	1
20	68.2	138.5	58.1	67.7	1	1
25	71.3	140.4	60.3	71.7	1	1

Regarding the Height, after Fertigation in canal (3) table (8) showed that total Height of the plant was least in the first week reached (68.2) on distance of (5 and 20 meters) and the total Height of the plant highest in the first week was (71.3) on distance (25 meters), the highest reading for plant height with total Height was (140.4) in the Second week, on distance (25 meters).

Regarding the number of leaves of the Plant after Fertigation in canal (3) table (8) showed that total number of Leaves of the plant was least in the first week reached (57.8) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (60.3) on distance (25 meters), the highest reading for number Leaves of the plant with total was (71.7) in the second week, on distance (25 meters).

Regarding the number of Fruit after Fertigation in canal (3) table (8) showed that there was one fruit on the plant in the first week on distances (5.10, 15, 20 and 25) meters, while it remained one fruit in the second week on all distances.

Table.9: (Height, No. of leaves and No. of fruits after fertigation for canal 4).

Distance (m)	Height (cm)		No. of Leaves		No. of Fruits	
	Week1	Week2	Week1	Week2	Week1	Week2
5	35.1	95.1	44.5	65	1	1
10	58.8	98.3	46.8	68.2	1	1
15	57.4	97.9	48	68.9	1	1
20	59.6	101.1	47.1	70.6	1	1
25	60.1	100.5	49.8	69.9	1	1

Regarding the Height, after Fertigation in canal (4) table (9) showed that total Height of the plant was least in the first week reached (35.1) on distance of (5) and the total Height of the plant highest in the first week was (60.1) on distance (25 meters), the highest reading for plant height with total Height was (101.1) in the Second week, on distance (20 meters).

Regarding the number of leaves of the Plant after Fertigation in canal (4) table (9) showed that total number of Leaves of the plant was least in the first week reached (44.5) on distance of (5 meters) and the total number of Leaves of the plant Highest in the first week was (49.8) on distance (25 meters), the highest reading for number Leaves of the plant with total was (70.6) in the second week, on distance (20 meters).

Regarding the number of Fruit after Fertigation in canal (4) table (9) showed that there was one fruit on the plant in the first week on distances (5.10, 15, 20 and 25) meters, while it remained one fruit in the second week on all distances.

4.2 Total Sugar (Energy Budget)

Table (10) showed make the total sugar in Refractrometer test, the result view increased in total of Sugar Concentrations in canal (2) and (3), and the result are equal in the channel (1) and the Blank canal, because more fertilizer were added to these two canals (2 and 3), and the addition of macronutrient (K) is an important element that produces sugar in the plant and concentrates it.

Table .10: (Total Sugar Concentrations using Refractrometer).

Distance(m)	Canal (1)	Canal (2)	Canal (3)	Canal (blank)
5	3.2%	6.12%	6.23%	3.55%
10	3.2%	6.5%	6.475%	3.47%
15	3.5%	5.9%	5.93%	3.3%
20	3.55%	6.15%	6.3%	3.2%
25	3.375%	6.6%	6.125%	3.4%

4.3 Fertigations

4.3.1 Nitrogen

FromTable.(11) making a test for nitrogen Proportion in different parts of the plant with different concentrations of fertilizer, indicated that the stem and the leaves had the large proportion of nitrogen, then roots, and finally the fruits.

The Nitrogen concentrates in the leaves when added to the plant. Another indication about nitrogen results was, blank canal has the less proportion of nitrogen than canal 1, after that canal 3 and canal 2 with the largeproportion . Adding salt(NaCL) to canal 3 prevents the plant from absorbing all the nutrient found in water, which lead to decrease in nitrogen proportion found in the plants in this canal .

Table .11: (Nitrogen Percent (N%) by Kjeldahl method).

No. of Canals	Stem and leaves	Roots	Fruits	No. of Canals	Stem and leaves	Roots	Fruits
1-section 1	0.2268	0.1371	0.1094	3-section 1	0.7983	0.1986	0.1615
1-section 2	0.2365	0.1298	0.1098	3-section 2	0.8798	0.1945	0.1707
1-section 3	0.2412	0.1325	0.1121	3-section 3	0.7854	0.1848	0.1620
2-section 1	1.7556	0.2976	0.2654	4-section 1	0.1875	0.1225	0.1069
2-section 2	1.8432	0.2854	0.2725	4-section 2	0.1872	0.1221	0.1055
2-section 3	1.7984	0.2901	0.2810	4-section 3	0.1871	0.1243	.1038

4.3.2 Phosphorus

From Table .(12) stem and leaves had the large value of phosphorus because this element has a role in plant photosynthesis which concentrate it in the leaves, but comparison between the canals indicate that, canal (2) had the largest value because more fertilizer was added to this canal than canals (1) and blank. The same amount of fertilizer was added to canal (3) but adding the salt (NaCl) to it decreased the absorption of phosphorus from water.

Table .12: (Phosphorus concentrations in plants (ppm).

No. of Canals	Stem and leaves	Roots	Fruits	No. of Canals	Stem and leaves	Roots	Fruits
1-section 1	0.458	0.273	0.125	3-section 1	0.632	0.433	0.298
1-section 2	0.451	0.278	0.131	3-section 2	0.618	0.438	0.295
1-section 3	0.457	0.271	0.129	3-section 3	0.625	0.429	0.291
2-section 1	0.830	0.587	0.395	4-section 1	0.412	0.210	0.110
2-section 2	0.876	0.598	0.393	4-section 2	0.398	0.205	0.109
2-section 3	0.877	0.587	0.389	4-section 3	0.401	0.212	0.115

Table.13: (Standard with different concentration to measure the absorbance).

Standard concentration	.4	.6	.8	1	2	3	4	6	8
Standard Volume(ml)	1	1.5	2	2.5	5	7.5	10	15	20
Reagent volume(ml)	4	4	4	4	4	4	4	4	4

Table (13) Showed that Standard Concentration are increased, and the Standard Volume are increased, on the other hand Reagent Volume are Equal, and Figure (1) Show that .

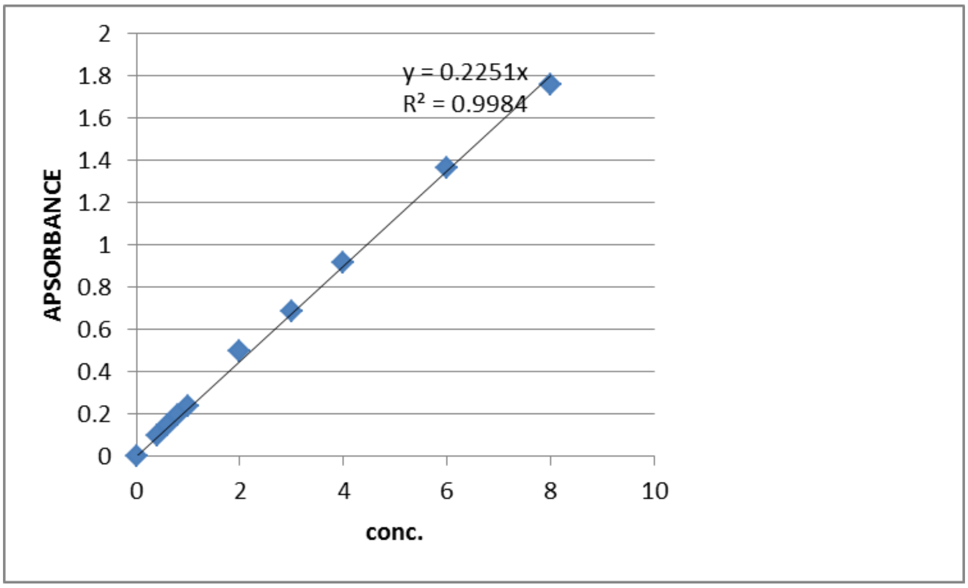

Fig.5: (Standard with different concentration to measure the absorbance of phosphorus).

4.3.3 Potassium :

Table.(14) shows that amount of absorbed potassium differs in different parts of the plant, roots have the largest value compared with the(stem and leaves) and fruits , this is because this element should be added to the plant in the fruiting stage since adding more potassium before this stage or after it makes potassium accumulate in a different part of the plant especially in the roots .But making a comparison between four canals indicate that canal (2) had the largest values, because more fertilizer added to this canal comparing with canals (1) and no fertilizer is added to blank , but the difference appears in canal (3) to which the same amount of fertilizer was added to it like canal (2) but the presence of salt (NaCl) prevents the absorption of potassium from water.

Table .14: (Potassium concentrations in plants (ppm).

No. of Canals	Stem and Leaves	Roots	Fruits	No. of Canals	Stem and Leaves	Roots	Fruits
1-section1	0.2650	0.5049	0.2050	3-section1	0.3150	0.6982	0.2400
1-section2	0.2750	0.5058	0.2000	3-section2	0.3160	0.6899	0.2350
1-section3	0.2690	0.5047	0.2050	3-section3	0.3180	0.6987	0.2400
2-section1	0.3950	0.8519	0.2850	4-section1	0.1950	0.3759	0.1900
2-section2	0.3980	0.8521	0.2850	4-section2	0.1960	0.3768	0.1850
2-section3	0.3970	0.8524	0.2900	4-section3	0.1980	0.3761	0.1900

4.4 Total Dissolved Solids (SALT)

From Table.(15) results for measuring conductivity indicate that, stem and leaves had the largest value than roots and fruits which is least one. But making a comparison between the four canals; canal 3 has the largest value, because salt (NaCl) was added to this canal, but the remain canal just fertilizer were added to them, except the blank no fertilize add to it .

Table .15: (Conductivity test by electrical conductivity meter(μs/cm).

No. of Canals	Stem and leaves	Roots	Fruits	No. of Canals	Stem and leaves	Roots	Fruits
1-section1	0.169	0.1080	0.0538	3-section1	0.301	0.1723	0.1095
1-section2	0.161	0.1005	0.0520	3-section2	0.307	0.1790	0.1121
1-section3	0.165	0.1012	0.0512	3-section3	0.310	0.1785	0.1113
2-section1	0.244	0.1486	0.0743	4-section1	0.101	0.0947	0.0499
2-section2	0.251	0.1422	0.0778	4-section2	0.103	0.0889	0.0521
2-section3	0.248	0.1432	0.0775	4-section3	0.106	0.0958	0.0498

4.5 Comparative Analysis

4.5.1 Growth of Muskmelon

4.5.1.1 Height

From (Fig.6) making a comparison between four canals about the height in the first week before adding fertilizer indicates that, the same growth in the plant height in all the canals were observed .

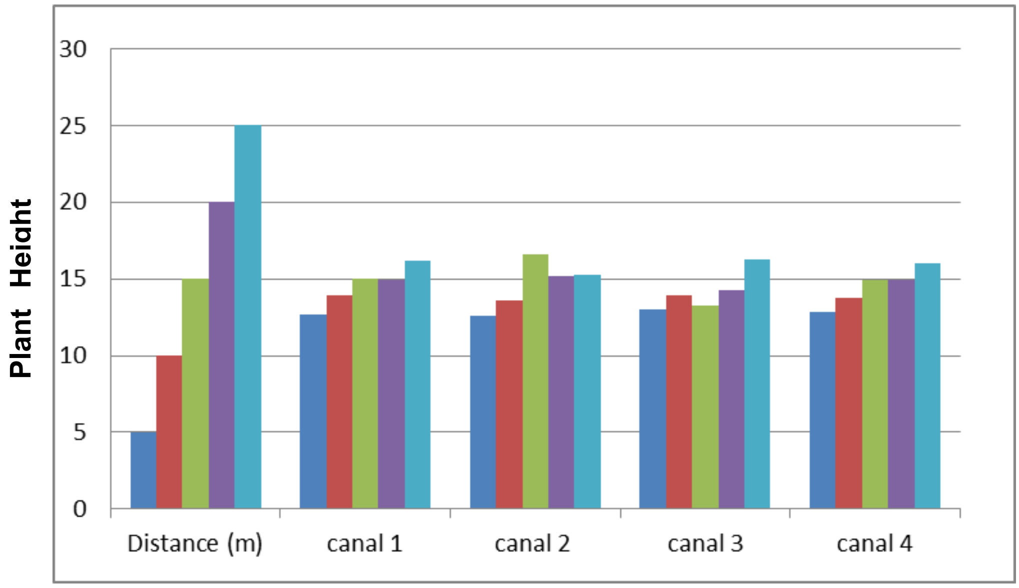

Fig .6: Height (cm) in week (1) before fertigation for four canals.

From (Fig.7) making a comparison between four canals about the plant height in the second week before adding fertilizer indicates that, the same growth in the plants height in the four canals.

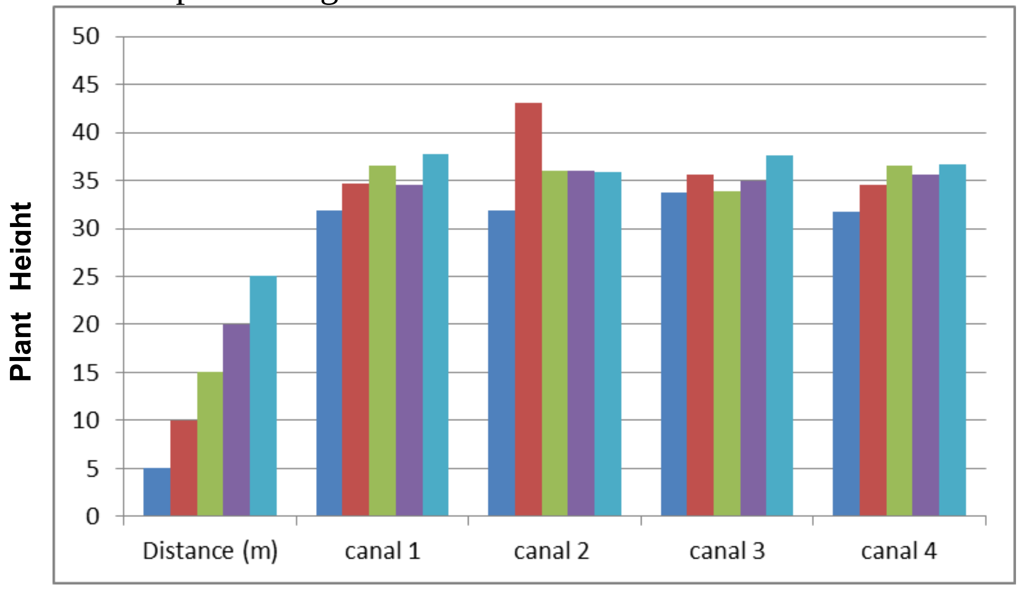

Fig .7: Height(cm)in week (2) before fertigation for four canals.

From (Fig.8) making comparison between four canals about the plant height in the third week before adding fertilize indicates that, the same growth in the plants height in the four canals.

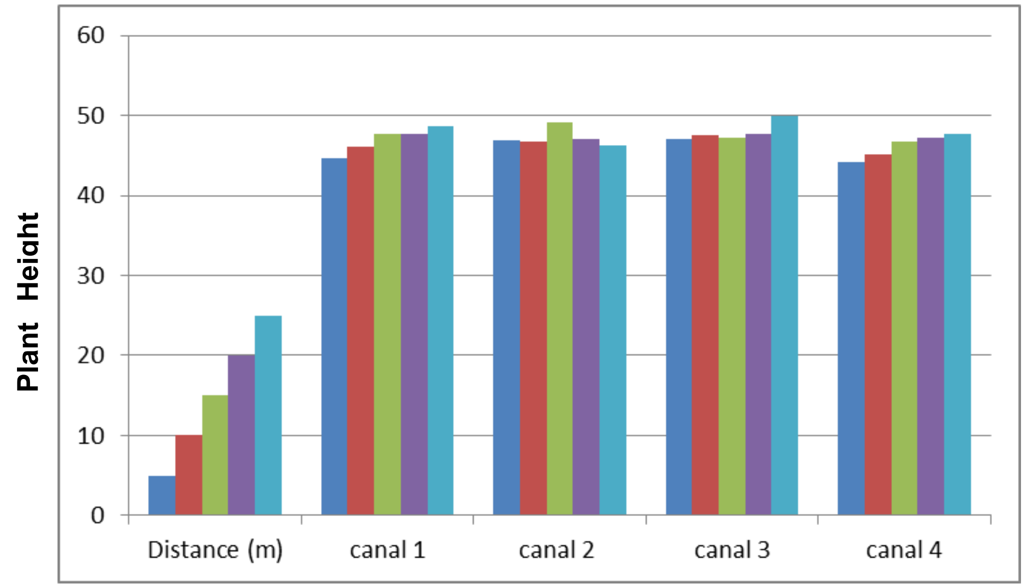

Fig.8 : Height (cm) in week (3) before fertigation for four canals

From (Fig.9) ,after adding fertilizer, the canals to which more fertilizer are added to them appear with more plant height like canals (2)and (3) .But canal (1) had less length growth because a little amount of fertilizer is added to it ,while the blank has no fertilizer been added .

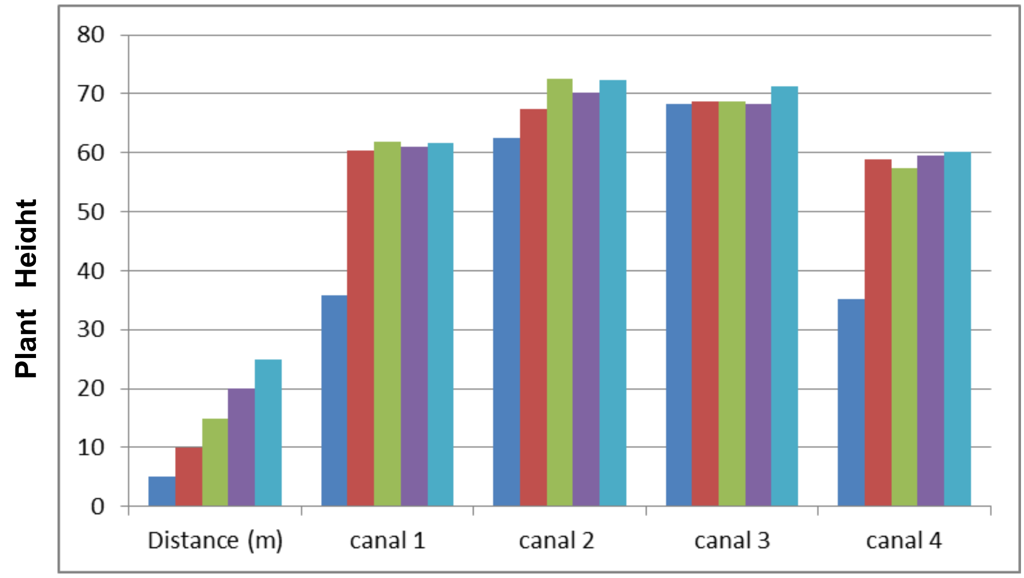

Fig .9: Height(cm)in week (1) after fertigation for four canals.

From (Fig.10) , in the second week of adding fertilizer, more growth in plant height compared with the first week was seen. The canals which more fertilizer added to them appear with more plant height like canals (2)and (3). But canals (1) has less growth because a little amounts of fertilizer is added whereas no fertilizers are added to the blank canal .

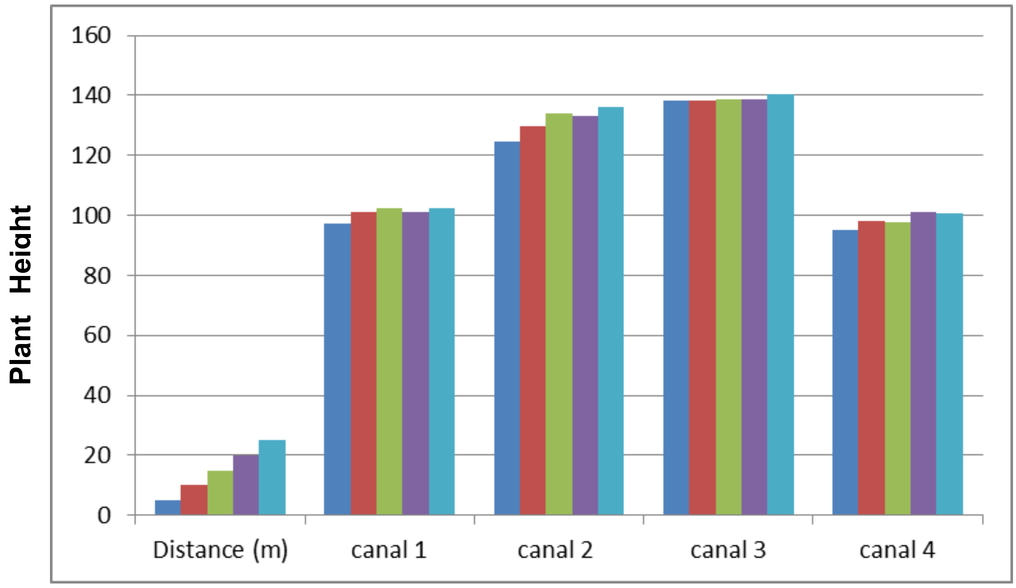

Fig.10 : Height(cm)in week (2) after fertigation for four canals.

4.5.1.2 Leaves

From (Fig.11) ,leaves number in week (1) for the same canal increased with distance due to some reason:1.the distance between the plant is more adjacent to the other in the beginning of the canal compared with the others in the middle and the end of the canal . 2.the slope of the canal making the plant at the beginning had less opportunity to obtain water.

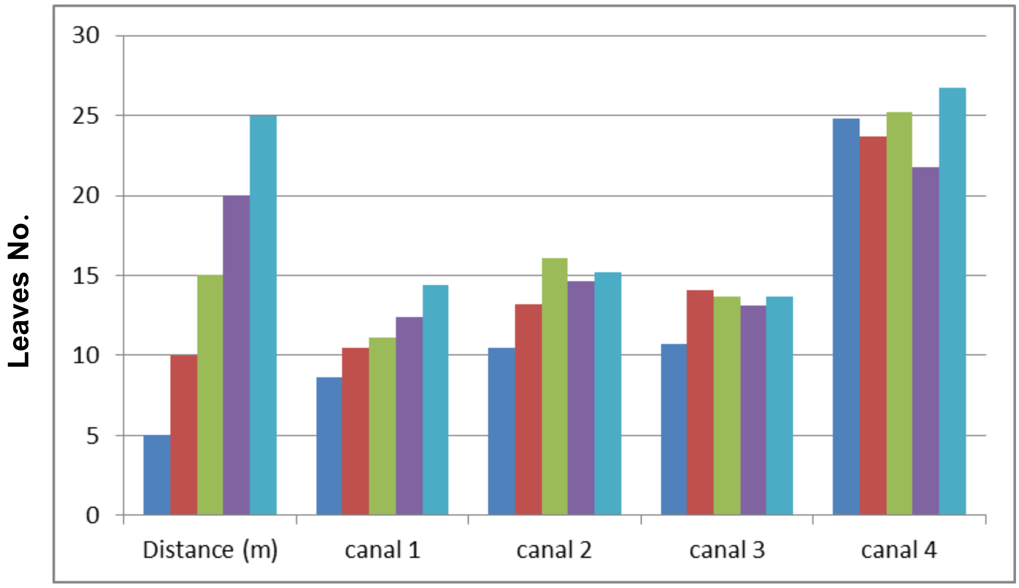

Fig .11: No. of leaves in week (1) before fertigation for four canals .

From (Fig.12): leaves number in week (2) before fertigation for four canals increased with the distance, like canals (2)and(3), but canals (1) and(blank) had less leaves number .

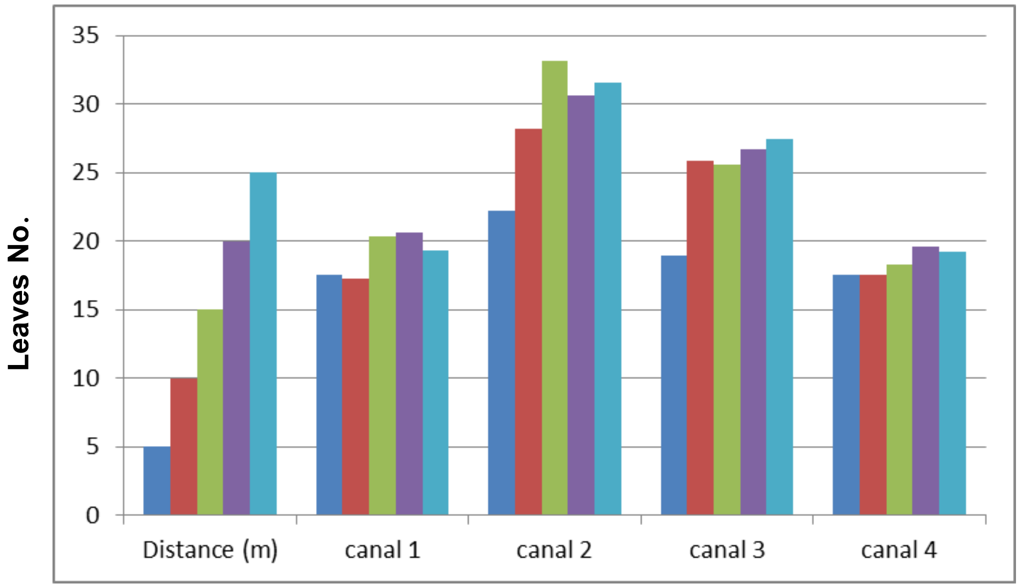

Fig .12: No. of leaves in week (2) before fertigation for four canals .

From (Fig.13) the number of leaves in week(3) increased with the distance, like canals (2)and (3), but canals (1) and(blank) had less leaves number.

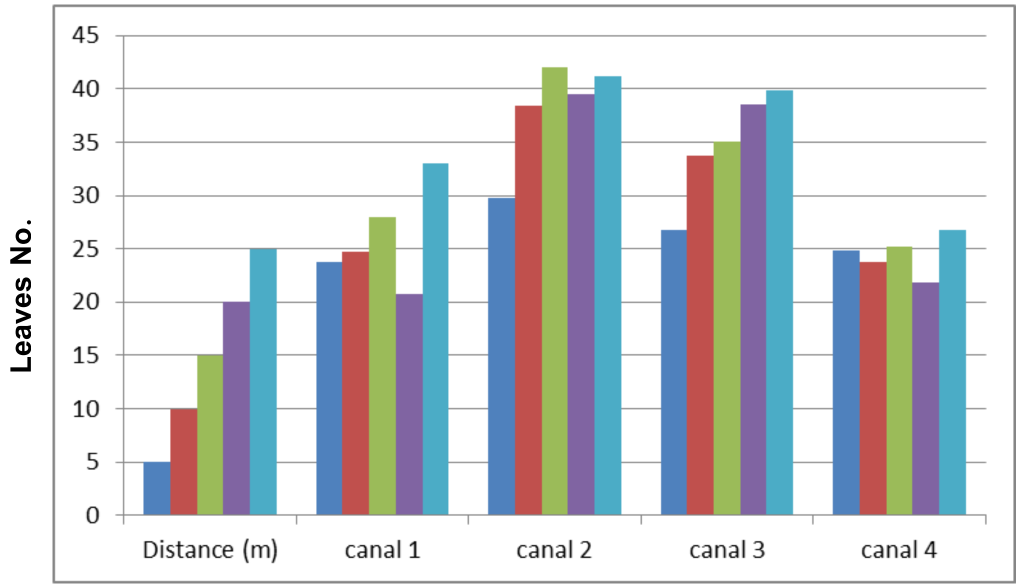

Fig .13: No. of leaves in week (3) before fertigation for four canals .

From (Fig.14) . After adding fertilizers, canals with more fertilizer had more plant leaves like canals (2)and (3). But canals (1) had less plant leaves because little amount of fertilizer is added while blank canal wasn't fertilized .

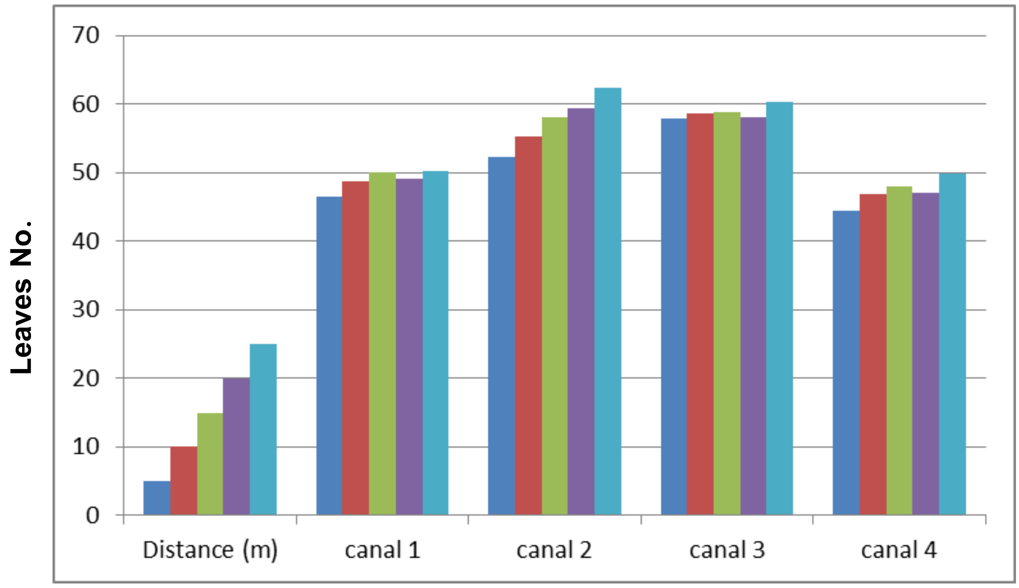

Fig .14: No. of leaves in week (1) after fertigation for four canals .

From (Fig.15), in the second week after adding fertilizer, number of plant leaves for all canals increased .

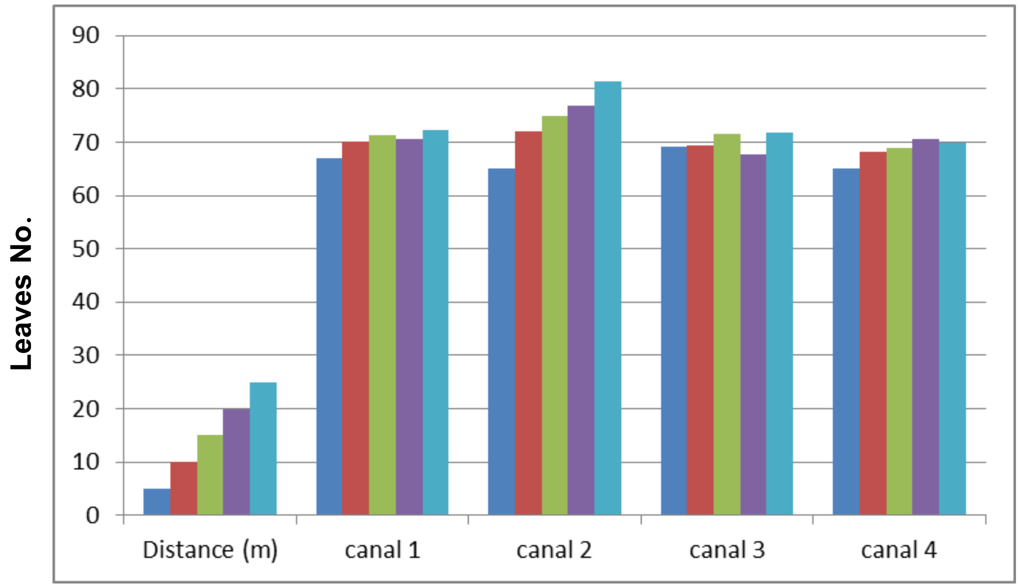

Fig .15: No. of leaves in week (2) after fertigation for four canals .

4.5.1.3 Fruits

In weeks 1 and 2 the number of fruits in the four canals was zero.

From (Fig.16) the number of fruits in the four canals in week (3) before adding fertilizer was nearly the same .

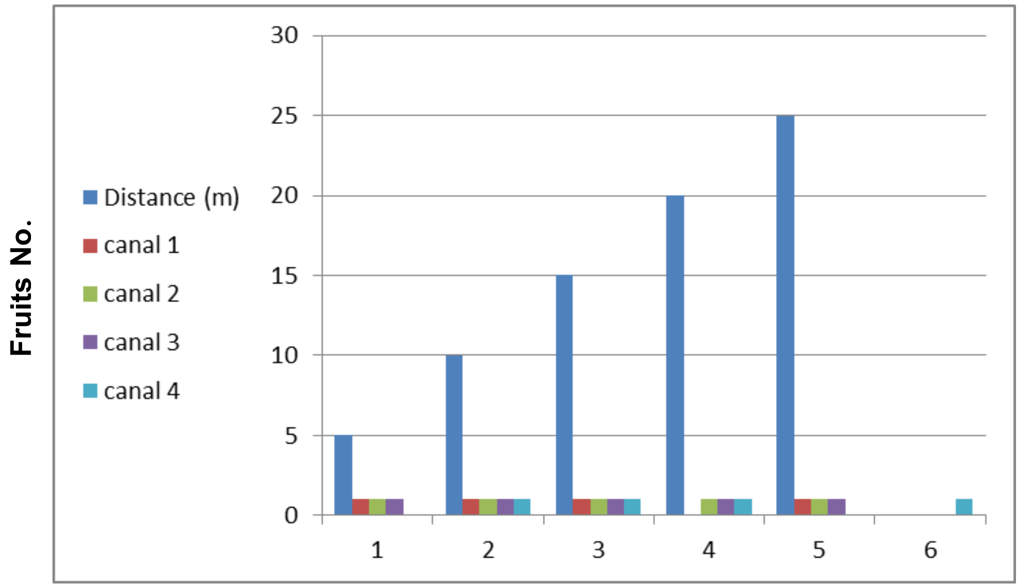

Fig .16 :No. of fruits in week(3) before fertigation for four canals .\

From (Fig.17) the number of fruits in the four canals in week (1) after adding fertilizer are the same .

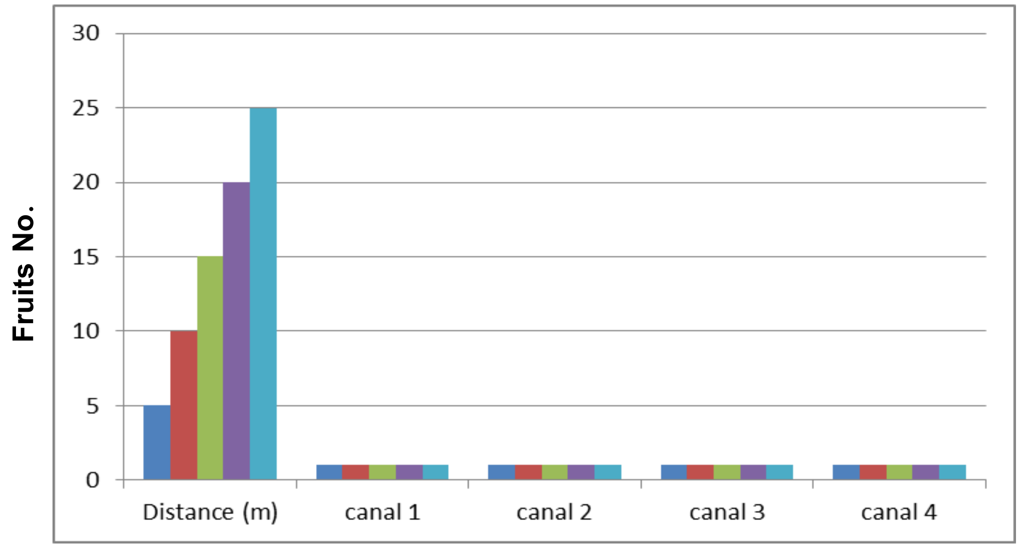

Fig .18 : No. of fruits in week(1) after fertigation for four canals .

From (Fig.17) the number of fruits in the four canals in week (2) after adding the fertilizer was nearly the same.

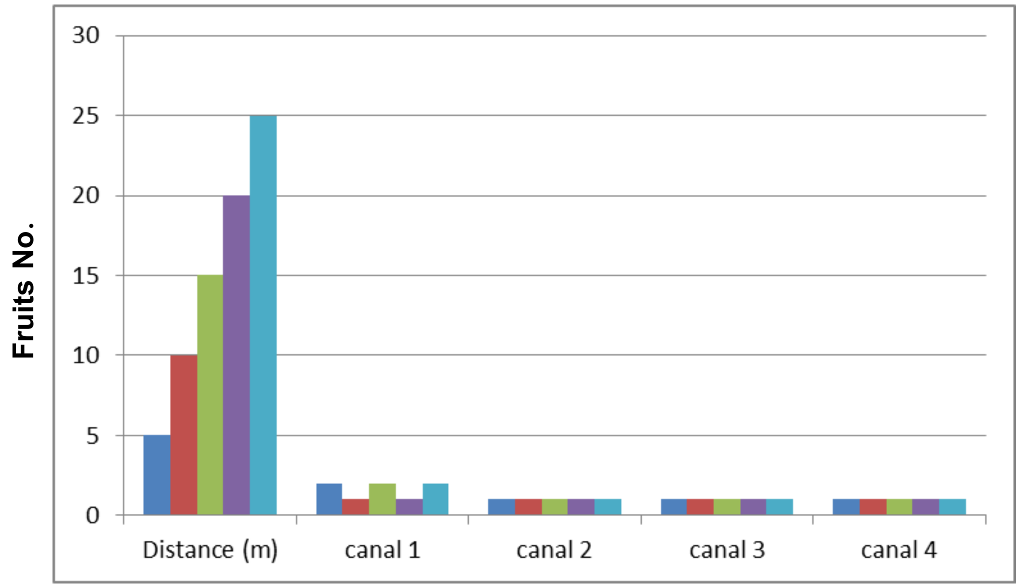

Fig .18 : No. of fruits in week(2) after fertigation for four canals .

4.5.2 Total Sugar Concentrations

From (Fig.19), the results of total sugar for canals 1 and blank were approximately equal and differ from canal (2 and 3) that have larger percent of total sugar in the plant. This was due to large amounts of fertilizer added to these two canals (2 and 3).

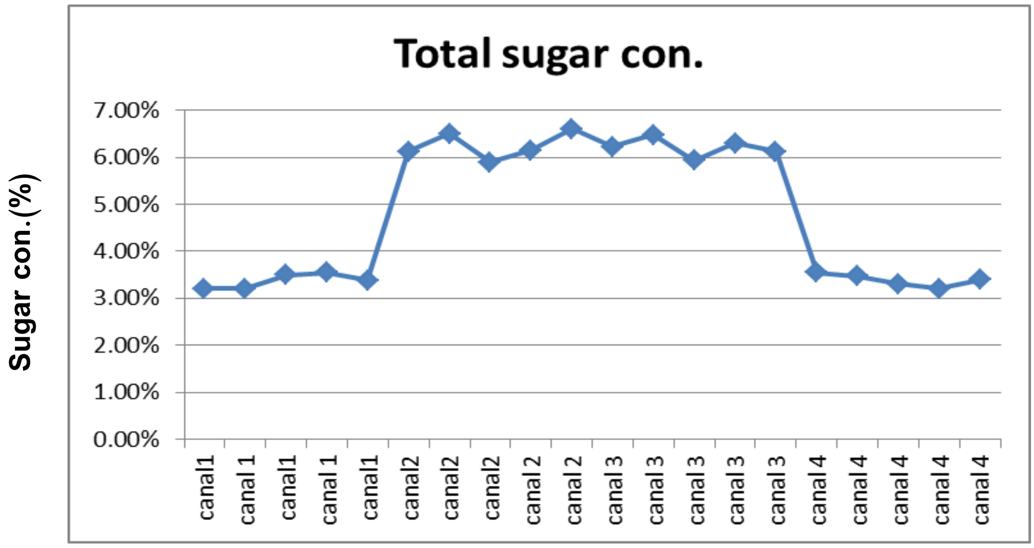

Fig .19 :Comparison for total sugar concentration between four canals.

4.5.3 Fertigation

4.5.3.1 Nitrogen

4.5.3.1.1 Stem and Leaves

From (Fig.20) Nitrogen percentage in stem and leaves had the largest percentage compared with roots and fruit, because nitrogen is concentrated in plant leaves. And it is observed that canal (2) had the largest value of nitrogen percentage compared with canals (1,3 and blank) .

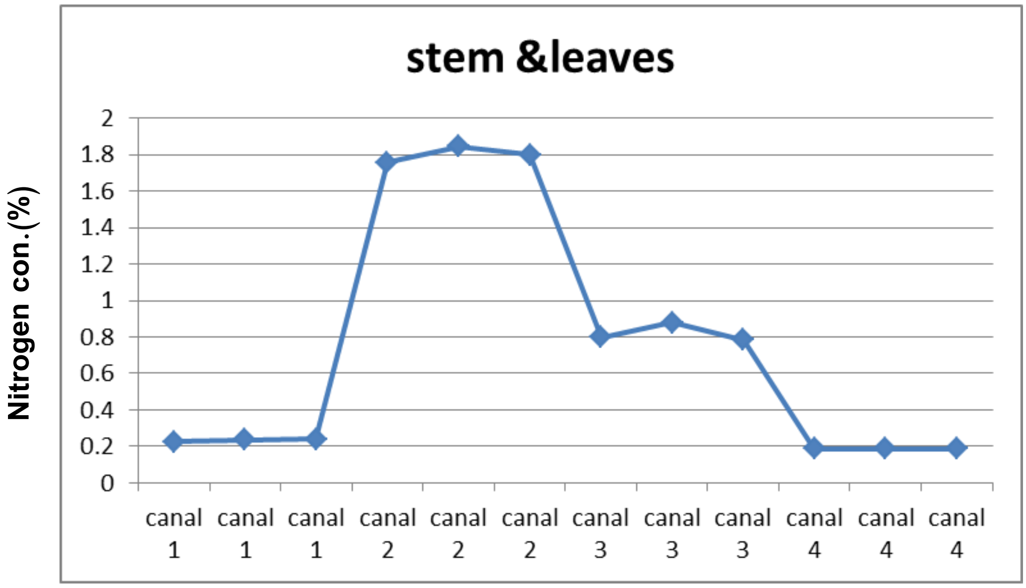

Fig .20: Comparison for nitrogen percent in stem and leaves between four canals.

4.5.3.1.2 Roots :

From (Fig 21) Results for nitrogen percentage in roots indicated that, canal (2) had the largest value of nitrogen percentage compared with canals (1,3 and blank) .

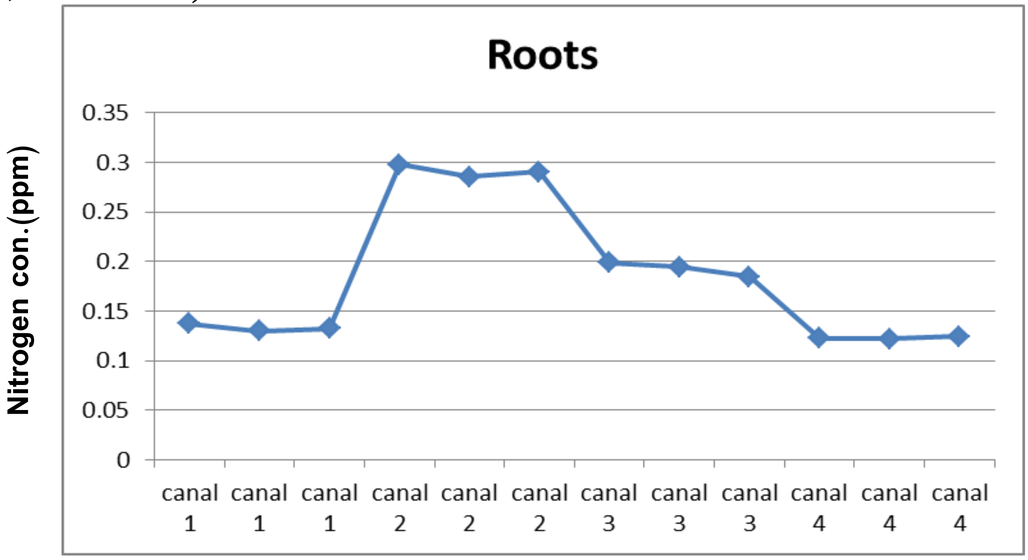

Fig .21: Comparison for nitrogen percent in roots between four canals.

4.5.3.1.3 Fruits

From (Fig.22)Results for nitrogen percentage in fruits indicated that, canal (2) had the largest value of nitrogen percentage compared with canals (1,3 and blank) .

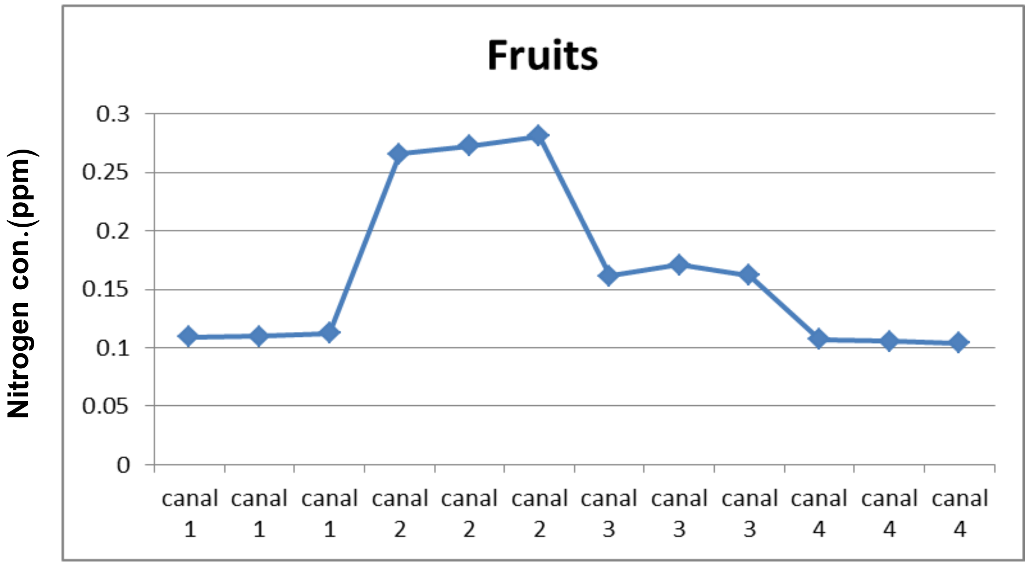

Fig .22 : Comparison for nitrogen percent in fruits between four canals.

4.5.3.2 Phosphorus

4.5.3.2.1 Stem and Leaves

From (Fig.23) Phosphorus concentrations in stem and leaves, they had the largest percentage compared with roots and fruit, because this element has a role in plant photosynthesis that concentrates phosphorus in plant leaves. And it is observed that canal(2) had a large value of phosphorus in comparison with canals (1,3 and blank).

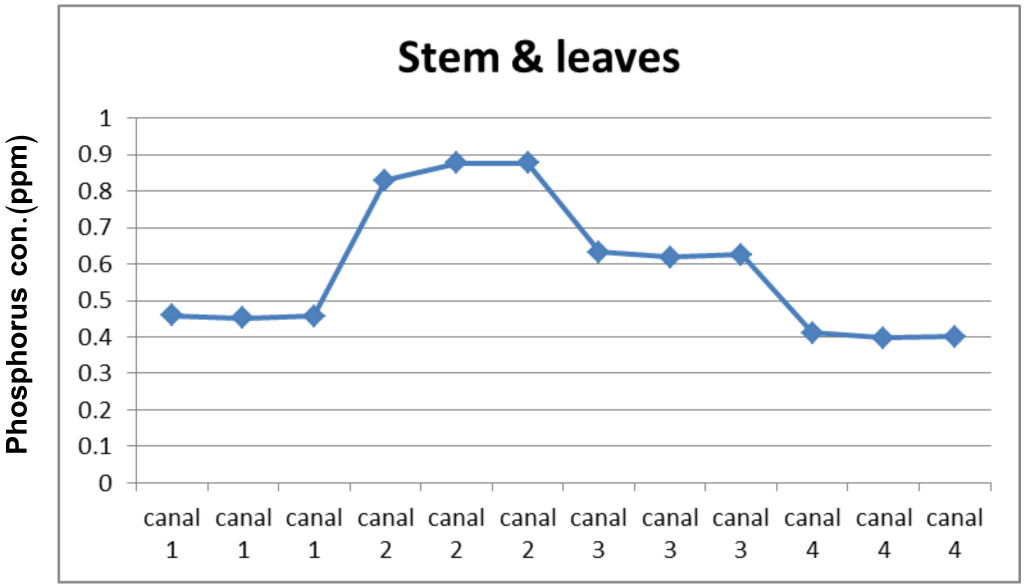

Fig .23: Comparison for phosphorus concentrations in stem and leaves between four canals.

4.5.3.2.2 Roots

From (Fig.24)Results for phosphorus concentrations in roots indicated that, canal (2) had the largest value of Phosphorus compared with canals (1,3 and blank) .

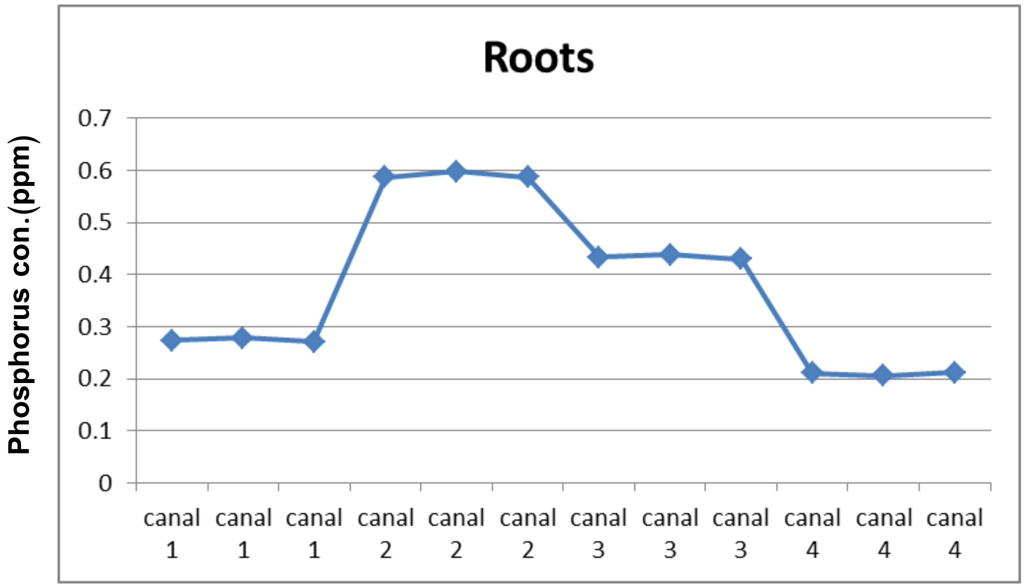

Fig .24 : Comparison for phosphorus concentrations in roots between four canals.

4.5.3.2.3 Fruits

From(Fig.25) Results for Phosphorus concentrations in fruits indicated that, canal (2) had the largest value of phosphorus compared with canals (1,3 and blank) .

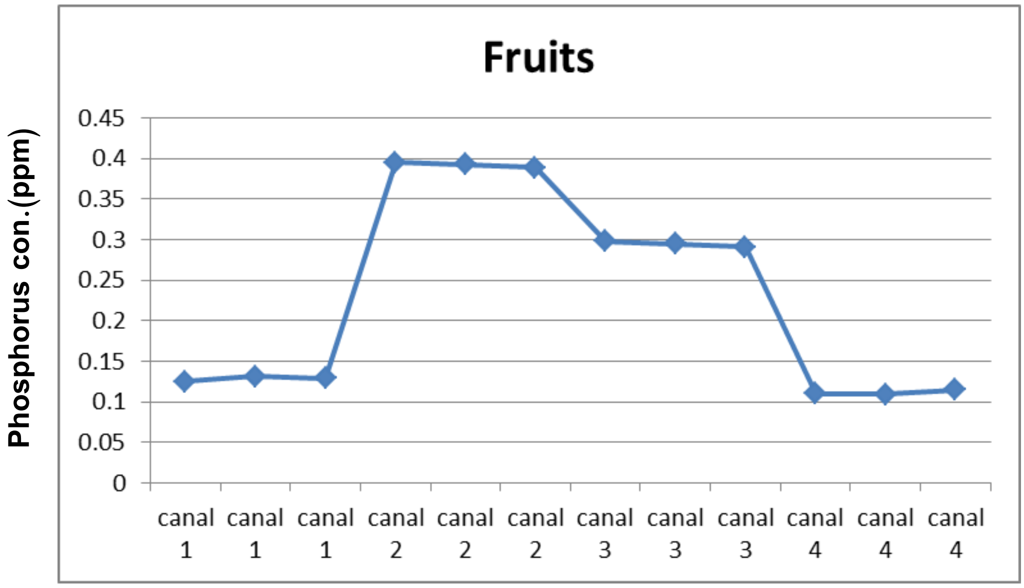

Fig .25: Comparison for phosphorus concentrations in fruits between four canals.

4.5.3.3 Potassium

4.5.3.3.1 Stem and Leaves :

From(Fig.26) Results for potassium concentrations in stem and leaves indicated that, canal (2) had the largest value of potassium compared with canals (1,3 and blank) .

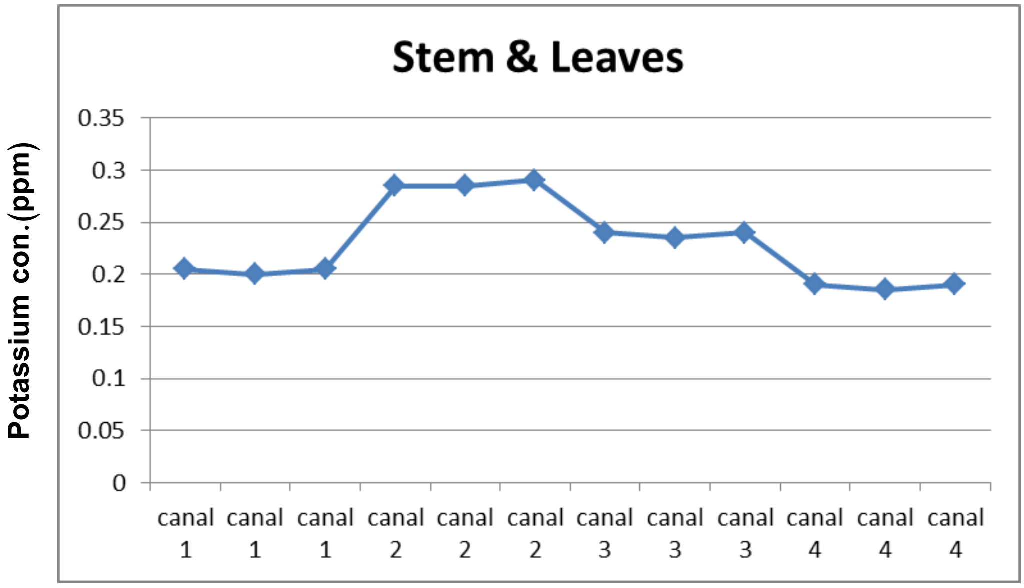

Fig .26 : Comparison for potassium concentrations in stem and leaves between four canals.

4.5.3.3.2 Roots

From(Fig.27) Potassium concentrations, roots have the large percent compared with (stem and leaves) and fruit , because these elements should be added to plant in the fruiting stage for this reason adding more potassium before this stage or after it make potassium accumulate in roots .But it is observed that canal(2) had a large value for potassium compared with canals (1,3 and blank).

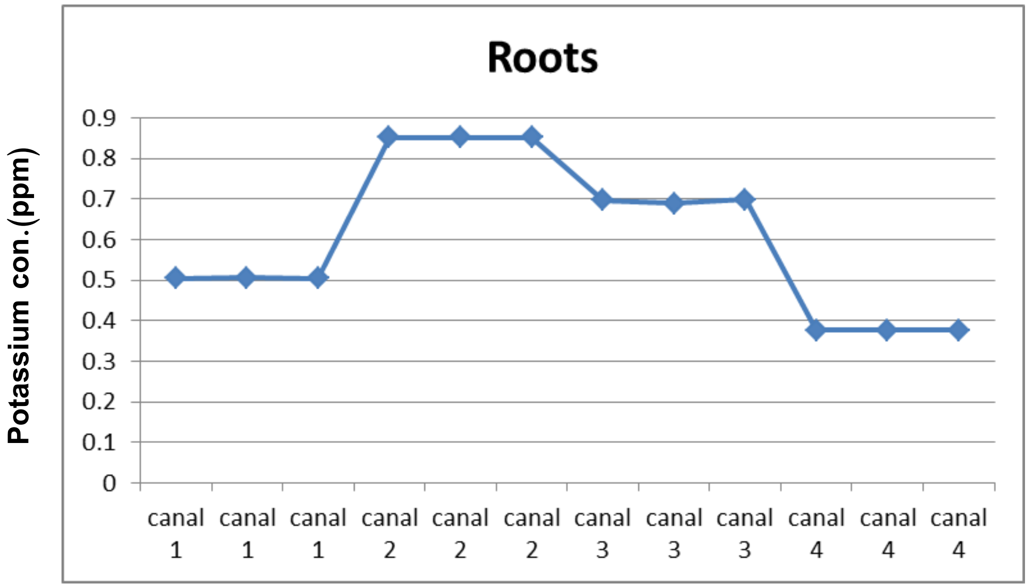

Fig. 27: Comparison for potassium concentrations in roots between four canals.

4.5.3.3.3 Fruits

From(Fig.28) Results for potassium concentrations in fruits indicated that, canal (2) had the largest value of potassium compared with canals (1,3 and blank) .

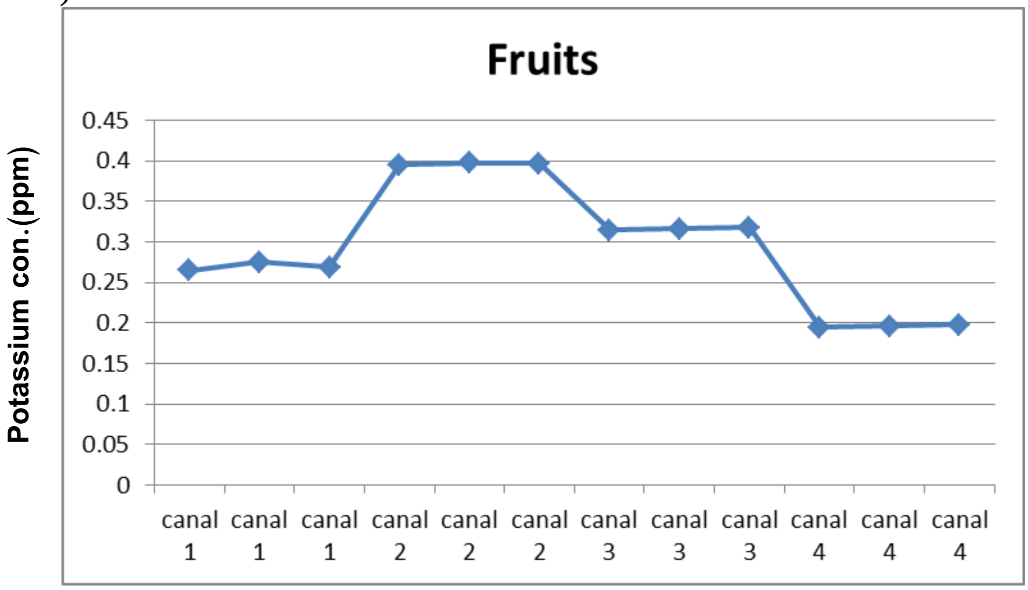

Fig .28: Comparison for potassium concentrations in fruits between four canals.

4.5.4 Total Dissolved Solid (SALT)

4.5.4.1 Stem and Leaves :

From (Fig.29) Conductivity results indicated that stems and leaves have the largest conductivity value in the same canal while roots and fruits have the least value . But making a comparison between the four canals , canal 3 has the largest value, because salt (NaCl) added to this canal**.**

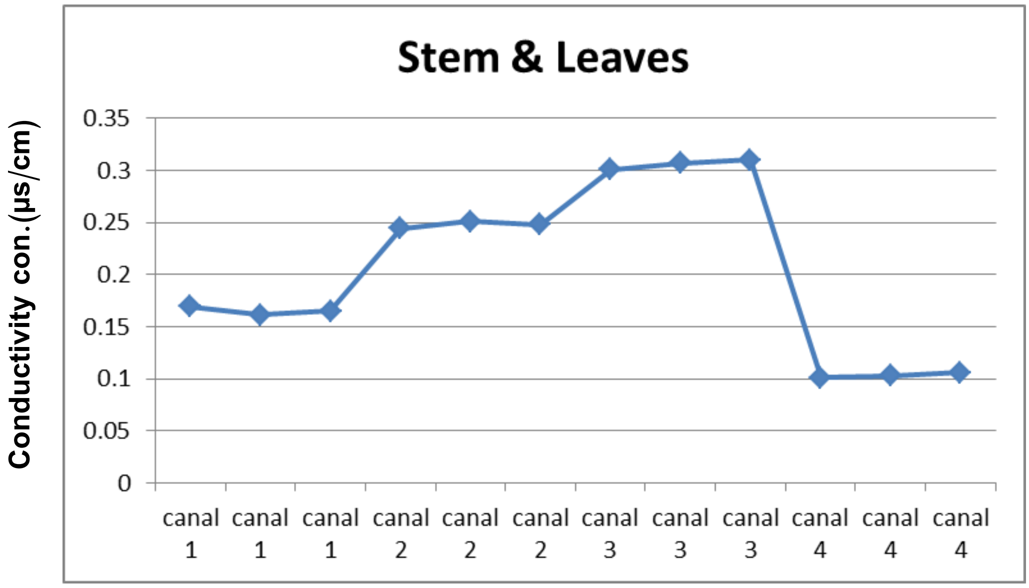

Fig .29 : Comparison for conductivity in stem and leaves between four canals.

4.5.4.2 Roots :

From(Fig.30) Results for conductivity value in roots indicated that, canal (3) had the largest value of conductivity compared with canals (1,2 and blank) .

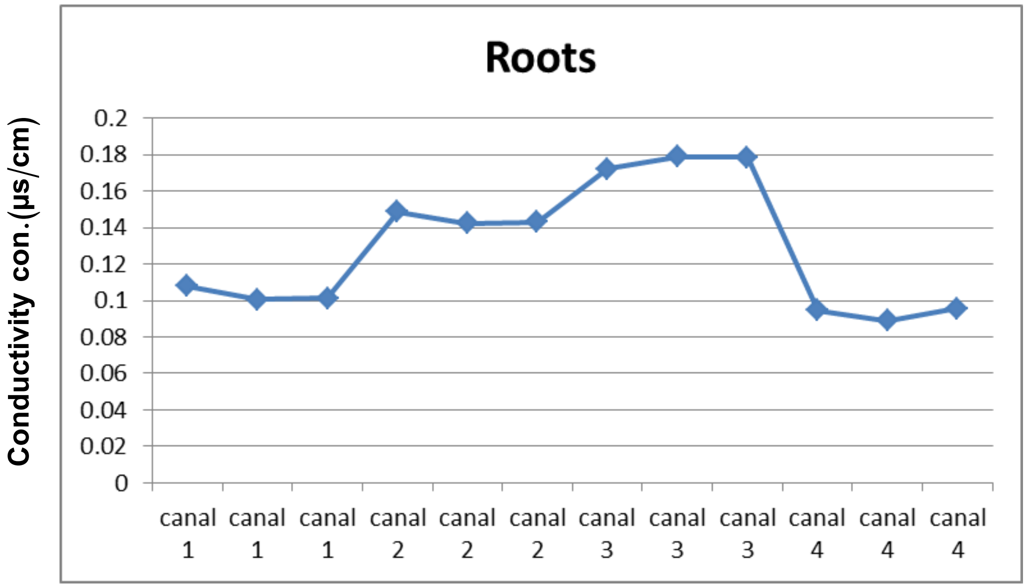

Fig .30 : Comparison for conductivity in roots between four canals**.**

4.5.4.3 Fruits

From(Fig.31) Results for conductivity value in fruits indicated that, canal (3) had the largest value of conductivity compared with canals (1,2 and blank) .

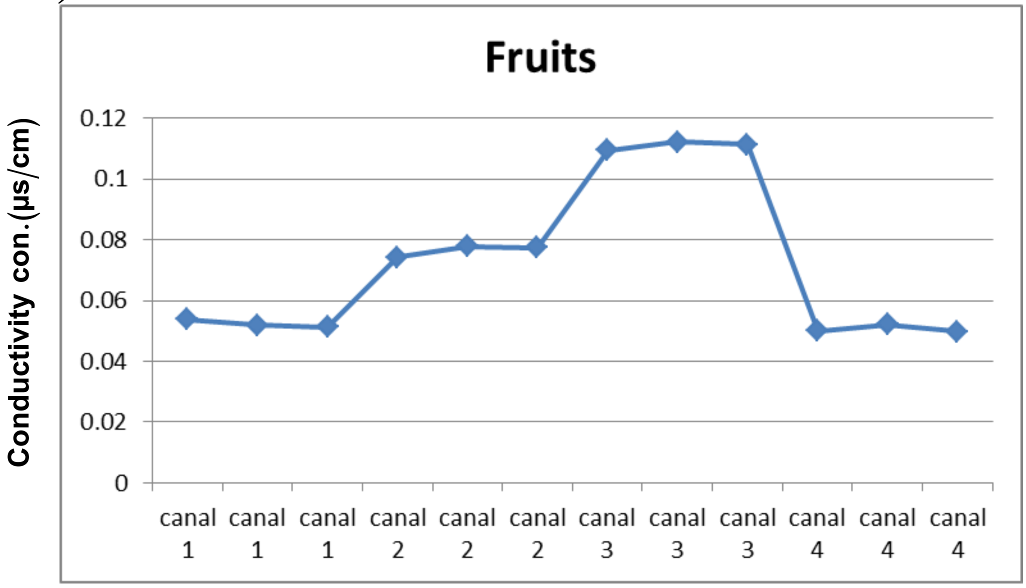

Fig .31 : Comparison for conductivity in fruits between four canals**.**

4.6 Statistical Analysis

4.6.1 Paired Samples (t-test)

To compare and see the differences in fruit, leaves and plant's height between the three channels before and after fertilization (Paired samples t-Test) was used as an evident in the following table:

Table .16: (Paired samples t-Test) to illustrate the differences in the first channel before and after fertilization.

Type	Dimensions	Mean value	Standard deviation	t value	Degree of freedom	Statistical significance
No. of Fruits	Before	.2667	.14907	-10.633-	4	.000
	After	1.3000	.27386			
No. of Leaves	Before	10.1333	1.10428	-113.294-	4	.000
	After	59.6000	1.72952			
Height	Before	29.1867	2.26073	-19.308-	4	.000
	After	78.4700	6.74552			

Table (16) shows that there were statistically significant differences between mean of number of fruit before using fertilization and after using fertilization in canal (1), where (t) value was (-10.633) with Significant at level (0.05). The significant Differences were in favor to Number of Fruits after using fertilization.

And Table (16) shows that there were statistically significant differences between mean of number of leaves before using fertilization and after using fertilization, where (t) value was (-113.294) with significance at level (0.05). The significant differences were in favor to Number of leaves after using fertilization.

Table (16) Shows that there were statistically significant differences between mean of height before using fertilization and after using fertilization, where (t) value was (-19.308) with significance at level (0.05). The significant differences were favor to height after using fertilization.

Table .17: (Paired samples t-Test) to show the differences in the second canal before and after fertilization.

Type	Dimensions	Mean value	Standard deviation	t value	Degree of freedom	Statistical significance
No. of Fruits	Before	.3333[a]	.00000	000	4	.000
	After	1.0000[a]	.00000			
No. of Leaves	Before	27.0800	3.76435	-33.447-	4	.000
	After	65.7300	4.98543			
Height	Before	32.8200	1.54912	-41.024-	4	.000
	After	100.2400	4.32802			

Table (17) Shows that there were statistically significant differences between mean of number of fruit before using fertilization and after using fertilization in canal (2), where (t) value was (0.000) with significance at level (0.05). The significant differences were in favor to Number of Fruits after using fertilization.

And Table (17) Shows that there were statistically significant differences between mean of number of leaves before using fertilization and after using fertilization, where (t) value was (-33.447) with significance at level (0.05). The significant differences were in favor to number of leaves after using fertilization.

Table (17) Shows that there were statistically significant differences between mean of height before using fertilization and after using fertilization, where (t) value was (-41.024) with significance at level (0.05). The significant Differences were favor to Height after using fertilization.

Table .18: (Paired samples t-Test) to illustrate the differences in the third canal before and after fertilization.

Type	Dimensions	Mean value	Standard deviation	t value	Degree of freedom	Statistical significance
No. of Fruits	Before	.3333[a]	.00000	.000	4	.000
	After	1.0000[a]	.00000			
No. of Leaves	Before	24.2400	3.21216	-30.769-	4	.000
	After	64.3200	1.25230			
Height	Before	32.4200	1.32970	-321.721-	4	.000
	After	103.9300	1.08432			

Table (18) Shows that there were statistically significant differences between mean of number of fruit before using fertilization and after using fertilization in canal (3), where (t) value was (0.000) with significance at level (0.05). The significant differences were in favor to Number of Fruits after using fertilization.

And Table (18) Showed that there were statistically significant differences between mean of number of leaves before using fertilization and after using fertilization, where (t) value was (-30.769) with significance at level (0.05). The significant Differences was favor to Number of leaves after using fertilization.

Table (18) Shows that there were statistically significant differences between mean of Height before using fertilization and after using fertilization, where (t) value was (-321.721) with significance at level (0.05). The significant differences were in favor to Height after using fertilization.

Table .19: (Paired samples t-Test) to illustrate the differences in the fourth canal before and during fertilization.

Type	Dimensions	Mean value	Standard deviations	t value	Degree of freedom	Statistical significance
No. of Fruits	Before	.2667	.14907	-11.000-	4	.000
	During	1.0000	.00000			
No. of Leaves	Before	17.7667	1.01297	-65.133-	4	.000
	During	57.8800	1.94216			
Height	Before	31.8933	1.55124	-19.392-	4	.000
	During	76.3900	6.41652			

Table (19) Shows that there were statistically significant differences between mean of number of fruit before using fertilization and during using fertilization in canal (4), where (t) value was (-11.000) with significance at level (0.05). The significant differences were in favor to Number of Fruits during using fertilization.

And Table (19) Shows that there were statistically significant differences between mean of number of leaves before using fertilization and during using fertilization, where (t) value was (-65.133) with significance at level (0.05). The significant differences were in favor to Number of leaves during using fertilization.

Table (19) Shows that there were statistically significant differences between mean of Height before using fertilization and during using fertilization, where (t) value was (-19.392) with significance at level (0.05). The significant differences were in favor to Height during using fertilization.

4.6.2 ANNOVA Test

To find out the differences between the canals in the examination of nitrogen, phosphorus, potassium, salinity, and sugar ANNOVA test was used and the following tables show the results of the examination.

4.6.2.1 Nitrogen ANNOVA test

Table .20: (The results of the analysis of variance for the significance of differences between canals in the examination of nitrogen).

Scale	Source of variation	Sum of squares of deviation	Degree of freedom	Average squares	(f) value	The level of significance
Leaves and stems	Between groups	5.062	3	1.687	1469.469	.000
	Within the groups	.009	8	.001		
	Total	5.071	11			
Roots	Between groups	.054	3	.018	692.240	.000
	Within the groups	.000	8	.000		
	Total	.054	11			
Fruits	Between groups	.055	3	.018	787.697	.000
	Within the groups	.000	8	.000		
	Total	.055	11			

Statistically significant at the level of (0.05) ANOVA *

From Table (20) shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to Canals, F Values was (1469.469, 692.240, 787.697) and it's Significance at level of (0.05) Respectively.

And to identify the differences were in favor of any Category of canals, the Researcher Used LSD test to identify these differences and table (21) show that:

Table .21: (L.S.D test results for the significance of the differences).

Scale		Canal 1	Canal 2	Canal 3	Canal 4	The level of significance
Leaves and stems	Canal 1		-1.56423-*	-.58633-*	.04757	.124
	Canal 2			.97790*	1.61180*	.000
	Canal 3				.63390*	.000
	Canal 4					
Roots	Canal 1		-.15790-*	-.05950-*	.01017*	.040
	Canal 2			.09840*	.16807*	.000
	Canal 3				.06967*	.000
	Canal 4					
Fruits	Canal 1		-.16253-*	-.05430-*	.00503	.235
	Canal 2			.10823*	.16757*	.000
	Canal 3				.05933*	.000
	Canal 4					

From Table (21) data indicate that the differences between four canals depending on the examination of nitrogen on plant (leaves and stems , roots and fruits) when making a comparisons is favor to second canal then favor to third Canal.

4.6.2.2 phosphorus ANNOVA Test

Table .22: (The results of the analysis of variance for the significance of differences between canals on the examination of phosphorus .

Scale	Source of variation	Sum of squares of deviation	Degrees of freedom	Average squares	(f) Value	Level of significance
Leaves and stems	Between groups	.382	3	.127	607.941	.000
	Within the groups	.002	8	.000		
	Total	.384	11			
Roots	Between groups	.263	3	.088	4045.829	.000
	Within the groups	.000	8	.000		
	Total	.263	11			
Fruits	Between groups	.165	3	.055	5316.839	.000
	Within the groups	.000	8	.000		
	Total	.165	11			

Statistically significant at the level of (0.05) ANOVA *

From Table (22) shows that there were Significance Statistically Differences between Leaves and steams, Roots, and Fruits Due to Canals on the examination of phosphorus, (F) Values was (607.941, 4045.829, 5316.839) and it's Significance at level of (0.05) Respectively, and to know for which canals is the benefit ,L.S.D was used and Table (23) shows the results.

Table .23: (L.S.D test results for the significance of differences).

Scale		Canal 1	Canal 2	Canal 3	Canal 4	Level of significance
Leaves and stems	Canal 1		-.40567-*	-.16967-*	.05167*	.002
	Canal 2			.23600*	.45733*	.000
	Canal 3				.22133*	.000
	Canal 4					
Roots	Canal 1		-.31667-*	-.15933-*	.06500*	.000
	Canal 2			.15733*	.38167*	.000
	Canal 3				.22433*	.000
	Canal 4					
Fruits	Canal 1		-.26400-*	-.16633-*	.01700*	.000
	Canal 2			.09767*	.28100*	.000
	Canal 3				.18333*	.000
	Canal 4					

From Table (23) data indicate that the differences between four canals growth for phosphorus examination on plant (leaves and stems , roots and fruits) when making a comparisons is favor to second canal then favor to third Canal then favor to first canal.

From Table (23) data indicate that the differences between four canals depending on the examination of phosphorus on plant (leaves and stems , roots and fruits) when making a comparisons is for the benefit for the second canal .

4.6.2.3 Potassium ANNOVA Test

Table .24(The results of analysis of variance for the significance of differences between canals on the examination of potassium) .

Scale	Source of variation	Sum of squares of deviation	Degrees of freedom	Average squares	(f) Value	Level of significance
Leaves and stems	Between groups	.064	3	.021	2618.704	.000
	Within the groups	.000	8	.000		
	Total	.064	11			
Roots	Between groups	.395	3	.132	20998.353	.000
	Within the groups	.000	8	.000		
	Total	.395	11			
Fruits	Between groups	.017	3	.006	687.000	.000
	Within the groups	.000	8	.000		
	Total	.017	11			

Statistically significant at the level of (0.05) ANOVA*

From Table (24) shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to canals on examination of potassium, (F) Values was (2618.704, 20998.353, 687.000) and it's Significance at level of (0.05) Respectively. and to know for which canals is the benefit ,L.S.D was used and Table (25) shows the results.

Table .25: (L.S.D test results for the significance of differences).

Scale		Canal 1	Canal 2	Canal 3	Canal 4	Level of significance
leaves and stems	Canal 1		-.12700-*	-.04667-*	.07333*	.000
	Canal 2			.08033*	.20033*	.000
	Canal 3				.12000*	.000
	Canal 4					
Roots	Canal 1		-.34700-	-.19047-*	.12887*	.000
	Canal 2			.15653*	.47587*	.000
	Canal 3				.31933*	.000
	Canal 4					
Fruits	Canal 1		-.08333-*	-.03500-*	.01500*	.000
	Canal 2			.04833*	.09833*	.000
	Canal 3				.05000*	.000
	Canal 4					

From Table (25) data indicate that the differences between four canals growth for examination of potassium on plant (leaves and stems , roots and fruits) when making a comparisons is favor to second canal then favor to third canal then favor to first canal.

4.6.2.4 Salinity ANNOVA Test.

Table .26: (The results of analysis of variance for the significance of differences between canals on the examination of salinity).

Scale	Source of variation	Sum of squares of deviation	Degrees of freedom	Average squares	(f) Value	Level of significance
Leaves and fruits	Between groups	.072	3	.024	1721.429	.000
	Within the groups	.000	8	.000		
	Total	.072	11			
Roots	Between groups	.013	3	.004	314.756	.000
	Within the groups	.000	8	.000		
	Total	.013	11			
Fruits	Between groups	.007	3	.002	1058.760	.000
	Within the groups	.000	8	.000		
	Total	.007	11			

Statistically significant at the level of (0.05) ANOVA*

FromTabl (26) shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to Canals on the examination of salinity, (F) Values was (1721.429, 314.756, 1058.760) and it's Significance at level of (0.05) Respectively and to know for which canals is the benefit ,L.S.D was used and Table (27) shows the results.

Table.27: (L.S.D test results for the significance of differences).

Scale		Canal 1	Canal 2	Canal 3	Canal 4	Level of significance
Leaves and stems	Canal1		-.08267-*	-.14100-*	.06167*	.000
	Canal2			-.05833-*	.14433*	.000
	Canal3				.20267*	.000
	Canal4					
Roots	Canal1		-.04143-*	-.07337-*	.01010*	.011
	Canal2			-.03193-*	.05153*	.000
	Canal3				.08347*	.000
	Canal4					
Fruits	Canal1		-.02420-*	-.05863-*	.00173	.159
	Canal2			-.03443-*	.02593*	.000
	Canal3				.06037*	.000
	Canal4					

From Table (27) data indicate that the differences between four canals growth for examination of salinity on plant (leaves and stems , roots and fruits) when making a comparisons is favor to third canal then favor to second canal.

4.6.2.5 Total Sugar ANNOVA Test

Table .28: (The results of analysis of variance for the significance of differences between channels on the examination of sugar total).

Scale	Source of variation	Sum of squares of deviation	Degrees of freedom	Average squares	(f) value	Level of significance
	Between groups	40.860	3	13.620	319.642	.000
	Within the groups	.682	16	.043		
	Total	41.542	19			

Statistically significant at the level of (0.05) ANOVA*

From Table (28) shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to Canals on the examination of sugar total, (F) Values was (319.642) and its Significance at level of (0.05) and to know for which canals is the benefit ,L.S.D was used and Table (29) shows the results.

Table.29: (L.S.D test results for the significance of differences)

Scale		Canal 1	Canal 2	Canal3	Canal 4	Level of significance
Total Sugar	Canal 1		-2.889-*	-2.847-*	-.019-	.886
	Canal 2			.042	2.870*	.752
	Canal 3				2.828*	.000
	Canal 4					

From Table (29) data indicate that the differences between four canals growth for examination of sugar on plant (leaves and stems , roots and fruits) when making a comparisons is favor to third canal then favor to second canal., but the third canal is approximately similar to the second canal .

4.7 summary

In summary the following results obtained :

1. Paired Samples (t-test)

To compare and see the differences in fruit, leaves and plant's height between the three channels before and after fertilization (Paired samples t-Test) was used.

results shows that there were statistically significant differences between means of growth (height, number of leaves and number of fruit) before using fertilization and after using fertilization in canals(1,2,3)with Significant at level (0.05). The significant Differences were in favor to growth after using fertilization.

2- ANNOVA Test

To find out the differences between the canals in the examination of nitrogen, phosphorus, potassium, salinity, and sugar ANNOVA test was used.

2.1 Nitrogen ANNOVA test.

Results shows that there were Significance Statistically Differences between (Leaves and stems), Roots, and Fruits Due to Canals, F Values was (1469.469, 692.240, 787.697) and it's Significance at level of (0.05) Respectively. Data indicate that the differences between four canals depending on the examination of nitrogen on plant (leaves and stems , roots and fruits) when making a comparisons is favor to second canal then favor to third Canal.

2.2 phosphorus ANNOVA Test.

Results shows that there were Significance Statistically Differences between (Leaves and stems), Roots, and Fruits Due to Canals on the examination of phosphorus, (F) Values was (607.941, 4045.829, 5316.839) and it's Significance at level of (0.05) Respectively. Data indicate that the differences between four canals depending on the examination of phosphorus on plant (leaves and stems , roots and fruits) when making a comparisons is for the benefit for the second canal .

2.3 Potassium ANNOVA Test.

Results shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to canals on examination of potassium, (F) Values was (2618.704, 20998.353, 687.000) and it's Significance at level of (0.05) Respectively. Data indicate that the differences between four canals growth for examination of potassium on plant (leaves and stems , roots and fruits) when making a comparisons is favor to second canal then favor to third canal then favor to first canal.

2.4 Salinity ANNOVA Test.

Results shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to Canals on the examination of salinity, (F) Values was (1721.429, 314.756, 1058.760) and its Significance at level of (0.05) Respectively. Data indicate that the differences between four canals growth for examination of salinity on plant (leaves and stems , roots and fruits) when making a comparisons is favor to third canal then favor to second canal.

2.5 Total Sugar ANNOVA Test

Results shows that there were Significance Statistically Differences between Leaves and stems, Roots, and Fruits Due to Canals on the examination of sugar total, (F) Values was (319.642) and its Significance at level of (0.05). Data indicate that the differences between four canals growth for examination of sugar on plant (leaves and stems , roots and fruits) when making a comparisons is favor to third canal then favor to second canal., but the third canal is approximately similar to the second canal .

Chapter Five

5. Conclusion

The current study was aiming at evaluating yield and energy budget of muskmelon grown in horizontal hydroponic system under different nutrient input conducted in a greenhouse in the new An-Najah National University campus**.** The study reached to many results that contributed to solve the study problem described in chapters one, answering the questions and hypotheses of the study. The main results are:

1. Plant growth in horizontal hydroponic system increased when Adding more fertilizer like canals (2) and (3) compared with canal 1and blank .
2. Energy budget increased when more fertilizer added to the plant like canals (2) and (3).
3. The presence of salt (NaCl) in canal (3) prevents plant from absorbing water and all nutrients from canal which leads to a decrease in plant productivity.
4. There was a significant positive effect after adding fertilizer on plant growth (height ,leaves number and fruits number) at level ($\alpha \leq 0.05$).
5. There was a significant positive effect of adding Nitrogen fertilizer in plant growth in canal (2) compared with other canals in which (N) is accumulate with large percent in stem and leaves then roots and after that fruits at level ($\alpha \leq 0.05$).
6. There was a significant positive effect of adding Phosphorus fertilizer in plant growth in canal (2) compared with other canals in

which (P) is accumulate with large percent in stem and leaves then roots and after that fruits at level ($\alpha \leq 0.05$).

7. There was a significant positive effect of adding Potassium fertilizer in plant growth in canal (2) compared with other canals in which p) is accumulate with large percent in roots hen stem and leaves and after that fruits at level ($\alpha \leq 0.05$).
8. There was a significant positive effect of total sugar test in canal (3) and canal (2) compared with other canals at level ($\alpha \leq 0.05$).
9. There was a significant positive effect of conductivity results in canal (3) compared with other canals in which salt (NaCl) accumulate with large percent in stem and leaves then roots and after that fruits at level ($\alpha \leq 0.05$).

From this starting point we had found that there is a relationship links between the plant growth in horizontal hydroponic system and energy budget of the plant with adding fertilizer without salt (NaCl) which lead to increaseplantproductivityandefficiencyofthesystem. .

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تقييم العائد وميزانية الطاقة لنبات الشمام المزروع في نظام مائي أفقي تحت نسب مغذيات مختلفة

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إشراف
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قدمت هذه الأطروحة استكمالا لمتطلبات الحصول على درجة الماجستير في العلوم البيئية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس– فلسطين.

2014

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الملخص

يهدف هذا البحث إلى تقييم المحصول و ميزانية الطاقة لنبات الشمام والتي تم زراعتها في نظام (الزراعة المائية الأفقية) تحت نسب مختلفة من المغذيات التي أجريت في دفيئة بلاستيكية في الحرم الجديد لجامعة النجاح الوطنية.

يتألف نظام (الزراعة المائية) من أربع قنوات مستطيلة معدنية (28 سم العرض،22 سم الارتفاع و 37 م طول القناة).تم زراعة أشتال الشمام في القنوات المائية مع اضافة نسب مختلفة من المغذيات (النيتروجين والبوتاسيوم والفسفور) ونسبة من الملوحة . وبعد انتهاء موسم زراعي واحد تم دراسة تأثير المغذيات والملوحة على نمو النبات وتقييم المحصول وميزانية الطاقة .

بدأت التجربة في 26 مارس 2013 كما يلي:

تم ملأ ثلاث قنوات بالمغذيات (النيتروجين و الفسفور و البوتاسيوم) بنسب مختلفة من التراكيز لكل قناة ((4/1)كوبر، (1)كوبر و(1) كوبر+ 1000جزء من المليون من ملح كلوريد الصوديوم .أما القناة الرابعة فتم استخدامها كمرجع ولم يتم إضافة أي من المغذيات إليها . تم السماح للمياه العذبة الموجودة في خزان بالدخول للنظام وملأ القنوات الأربعة ، أما الماء الزائد فتم تصريفه في نهاية كل قناة من خلال خزان الصرف .

بعد الانتهاء من التجربة تم تخزين المغذيات على درجة حرارة −20 لإجراء التحاليل اللازمة على كافة أجزاء النبتة من ساق وأوراق وجذور وثمار، حيث تم تحديد نسبة أيون النيتروجين باستخدام طريقة كلدال، وتم قياس تراكيز المواد الغذائية الأخرى (البوتاسيوم والفسفور) مباشرة في وقت واحد باستخدام مطياف الانبعاث.

وأشارت النتائج التي استخدمت في عملية التسميد لجميع المواد الغذائية على ما يلي :

1. لوحظ أن أعلى نسبة للنيتروجين تركزت في الساق والأوراق تليها الجذور ثم الثمار، وتبين أيضا أن القناة الثانية كانت تمتلك أعلى القيم من النيتروجين مقارنة بالقنوات الأولى والثالثة والرابعة .
2. تركز الفسفور في الساق والأوراق التي كانت تمتلك أعلى القيم تليها الجذور ثم الثمار، لأنه من المعرف ان عنصر الفسفور ضروري لعملية البناء الضوئي لذلك يتركز في الأوراق. وتبين أن القناة الثانية كانت تحمل أعلى القيم من الفسفور مقارنة بالقنوات الأولى والثالثة والرابعة .
3. لوحظ أن أعلى نسبة من عنصر البوتاسيوم تواجدت في الجذور مقارنة بالساق والأوراق والثمار ، ويعود السبب في ذلك إلى أن هذا العنصر يجب أن يضاف للنبات في مرحلة الإثمار، لذلك إضافة المزيد من البوتاسيوم قبل أو بعد مرحلة الإثمار تجعل البوتاسيوم يتراكم في الجذور .ولكن عند إجراء المقارنة بين القنوات الأربعة تبين أن القناة الثانية تحمل أعلى القيم من البوتاسيوم .
4. لوحظ من نتائج السكر أن القناة الأولى والرابعة تقريبا لها نفس القيم أما القناة الثانية والثالثة كانت تحمل أيضا قيم متقاربة ولكنها عالية ويعود السبب في ذلك إلى إضافة كميات كبيرة من المغذيات للقناتين الثانية والثالثة .
5. وأشارت نتائج نسبة الملوحة إلى أن الساق والأوراق كانت تمتلك أعلى القيم مقارنة بالجذور والثمار. أما عند إجراء المقارنة بين القنوات الأربعة فكانت القناة الثالثة تحمل أعلى القيم وذلك بسبب إضافة ملح كلوريد الصوديوم إليها دونا عن باقي القنوات الأخرى.

ومن النتائج التي تم التوصل إليها في هذا البحث ما يلي :

1. يزداد نمو النبات عند إضافة كمية كبيرة من المغذيات وهذا يظهر واضحا في القناتين الثانية والثالثة مقارنة بالقناتين الأولى والرابعة .
2. يزداد نسبة ميزان الطاقة (نسبة السكر في النبات) بزيادة كمية المغذيات المضافة كما في القناتين الثانية والثالثة .
3. وجود ملح كلوريد الصوديوم قلل من قدرة النبات على امتصاص المغذيات من النظام وبالتالي انخفضت إنتاجية النبات وكان هذا واضحا في القناة الثالثة