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Effects of Nutrients and Salinity on Yields, Growth, and Nutrients distribution of Faba Beans Grown in Hydroponics System

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Dedication

This work is dedicated to my beloved ,Father ,mother ,and my wife for their endless support, love, encouragement and understanding.

To my son and daughters .

To my brothers and sisters for tremendous help.

I don't forget to dedicate this work to my uncle Martyr Ibrahim abahra (mercy to him).

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الإقرار

أنا الموقعة أدناه مقدمة الرسالة التي تحمل العنوان:

Effects of Nutrients and Salinity on Yields, Growth, and Nutrients distribution of Faba Beans Grown in Hydroponics System

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List of Abbreviations

No	Abbreviation	Full Name
1	gm	gram
2	ppm	Part per million
3	Cm	Centi meter
4	Cm^2	Square centi meter
5	PH	plant height
6	NL	no of leaves
7	LFW	leaf fresh weight
8	LDW	leaf dry weight
9	SFW	stem fresh weight
10	SDW	stem dry weight
11	RFW	root fresh weight
12	RDW	root dry weight
13	ICP-MS	inductively coupled plasma mass spectrometry
14	ds/m^{-1}	deciSemiens per meter
15	EC	Electrical Conductivity

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Effect of nutrients and salinity on Yields, Growth, and Nutrients distribution of Faba Beans grown in Hydroponics systems.

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Abstract

Broad bean-Faba bean-(*Vicia faba* L.), one of the cultivated species of the family *Fabaceae*, is grown in nearly every part of Palestine. The importance of this study is to focus on important source of animal and human food beside it use new technique in agriculture which is the hydroponics system .The objective of this research was to evaluate the effect of two salinity levels (4.68ds/m-^{1} and 7.8 ds/m-^{1} NaCl) and three levels of Cooper nutrients solution (100% .25%. 300%) on the growth, yield and nutrient distribution in three Faba Beans cultivars (Baladi, Artasi, and Isbani), were grown in a hydroponics system, the experiment were divided into six group , two group had two salinity levels (4.68ds/m-^{1} and 7.8 ds/m-^{1} NaCl) , three group had three levels of Cooper nutrients solution (100% .25%. 300%) , and the last one contain water only (reference), each group contain three line, in each line one cultivars nutrients solution were supplied to the three cultivars freshly twice a day. Plants parts were desiccation and burning then turn it to solution in order to use it in analysis instrument. The results indicated that Increasing Cooper concentration ,increase plant height, leaves area, number of leaves, and number of pods, but decreased root length in the three cultivars .It was found that there is no significant different between (25% and 100%) cooper

solution in vegetative growth, while in 300% cooper solution ,there is a significant decrease in vegetative growth in the three cultivars ,but the three cultivars didn't produce pods, because plants died before reaching the flowering stage .Results show that application of Sodium chloride (4.68ds/m-^{1}) causes reductions in plant height, number of leaves, leaves area, and number of pods, but increasing the root length .while application (7.8 ds/m-^{1}) NaCl cause death in the flowering stage so that plants didn't produce pods. However, there is a decrease in plant height, number of leaves, leaves area, but significantly decrease root length.

There is no significant difference found between (4.68ds/m-^{1} and 7.8 ds/m-^{1} NaCl) in vegetative growth except no of pods and roots length . The result indicates that increased significantly in fresh and dry weight of vegetative growth in the three cultivars ,compared to the control ,when handled with cooper solutions, where there is no significant difference between 25% and 100% cooper solution .Application4.68ds/m-^{1} NaCl increased both fresh and dry weights of the shoot, roots, leaves and pods compared to the control ,but this increase not significantly.

According to the flame photometer (FP), and inductively coupled plasma mass spectrometry (ICP-MS) analyses of three cultivars were it include four lines (line 1,2,3 and 5), line 1(100% cooper solution) recorded highest amount of NO_3, SO_4, PO_4, K ,Zn, Mn ,Mo .compared to other lines. Line 2(25% cooper solution) show decrease in nutrients content, although there is no significant difference found in nutrients content between line 1 and 2,in line 3(4.68ds/m-^{1} NaCl) there is significant increase found in Na and

Cl and increase not significant in some nutrients compared to control line(line 5) like Mn,Cu,SO_4,NO_3,PO_4. Other nutrients like Cu, Mg didn't show significant difference between lines .Ca increased in line 5 and 3 but decreased in line 1and 2, no significant difference between cultivars in the lines was found. According to nutrients distribution in Faba bean parts for the three cultivars the result shows increasing nutrients in the roots like SO_4,Fe,Zn,Mn,Mo ,some nutrients show an increase in roots and leaves as: Mg ,Cu,NO_3, while Na and Cl accumulates in the roots and shoots, PO_4 accumulate in roots and pods, in addition to, Calcium(Ca) increased was found accumulate in leaves ,result show there is no significant different between nutrients in the three cultivars of Faba bean parts.

Its concluding that the effect of nutrients on Faba beans has been positive, where it increase vegetative growth and yield , but increase nutrients over a certain limit cause negative effects on vegetative growth and yield. And so vegetative growth and yields of Faba beans have been negatively affected by salinity . Also , it concludes that Baladi. and Isbani was slightly more resistance to salinity that might be a good choice to grow where the soils affected by NaCl at moderate stress levels .

Hydroponics systems are a new method of agriculture in many areas in the world ,so its need for application this systems on a large scale in Palestine, and Faba bean one of the plants that recommended to grow in it .

Chapter one

Introduction

1.1Overview

With the increasing of human population, the decreasing of agricultural area, the pollution which spread all over the world, and the sacristy of water source, which affect on our foods ,it has become an urgent need to improving agricultural methods and crops in order to cope with the new environmental conditions. One of the new methods that have been applied now in the world is hydroponic system , Hydroponics system is the production of plants in a soilless medium where nutrients are dissolved in water in order to supply to crop (Diver 2006). Hydroponics systems are being made in urban villages, but are slowly being introduced into commercial practices. These systems have many benefits which they are affiliated with. They conserve water usage, limits nutrient pollution, and it is much easier to harvest, hydroponics system doesn't require soil, pesticides, require less water and space than traditional agricultural system, and may be stacked in order to limit space use ,this makes them optimal for use in cities ,where space particularly limited . In Hydroponic systems, usually any types of plants can be grown successfully, vegetables, ornamentals and indoor plants are good examples of plants grown in hydroponics. The main important thing in growing any types of Hydroponic plants is their requirements for nutrients ,which needs more experience in making it . The importance of this study is being focused on a

major foodstuff in Palestine Faba beans, which is one of the essential legume crops grown in Palestine, mainly under rain fed conditions, Many Palestinian Faba bean farmers grow landraces meanwhile others grow imported cultivars because of their high productivity. Faba bean considers as a protein-rich food where it in developing countries provides human populations with a cheap protein source there for it compensates for the protein deficiency in poor human, whom lack animal protein sources. So that there are substantial research programs to improve its yield, disease resistance and nutritional quality (Maatallah, et.al, 2002). Agriculture of Faba beans in the world faces many challenges, one of them is salinity. Salinity defined as the accumulation of salts in soil and water to levels that impact on human and natural resource. Salinity one of the environmental problems that has become an increasingly important issue in developed and developing countries. Salinity come from many resources ,it may come from Salts in the soil, which resulting from the melting and continuous erosion of the rocks, The high level of ground water resulting from the absence of good drainage after irrigation, Seawater intrusion into the groundwater, especially in coastal areas, and Dissolved salts added through irrigation and fertilization (Ibrahem, 2011). Crops vary in their degree of response to salinity, where they classified according to salinity to tolerant, moderate tolerant and sensitive, Salinity cause negative effects on growth, yields, uptake of nutrients ,and biomass ,it may cause direct ion toxicity to plant tissue e.g. leaf burn, reduced availability of some elements and influence on osmosis i.e. plants have difficulty extracting soil water

(Podmore,2009). All plants need sources of nutrients where it plays an important role in its survive . Nutrients may come from decomposing plant and animal matter, and may come from parent material, rain and fertilizers. Plants can absorb nutrients from roots zone, but lack of some nutrients can compensate by added necessary nutrients as fertilizers. When the fertilizers put in the irrigation system its called Fertigation, Fertigation, is an abbreviation of two words fertilizers + irrigation, where it means is the process in which fertilizers are being applied to the irrigation water , in order to have effective Fertigation, experience and proper management must be available, application of fertilizer in the irrigation system need system which must be properly designed. Using Fertigation has many advantages it provides an accurate nutrients supply to plants, where it in the exact amounts that meet crop requirements, furthermore the efficiency of nutrient uptake increase, whereas nutrient loses minimized. However, using Fertigation requires careful management and many factors must be taken into consideration.

1.2 Objectives

The main aim of this research to identify the impact of salinity, and nutrient levels on Faba bean plants in piped hydroponics, and that by achieving the following objectives:

1. To evaluate some yield components for three Faba bean cultivars and some morphological parameters under different salinity level to determine the best salt and drought –tolerant varieties.

2. Comparison between the three cultivars of Faba beans plants under different concentrations of salinity and nutrients levels in terms of the number of pods, leaves and the length of stems and roots.
3. Comparison between biomass weight of the three cultivars of Fava beans under different concentrations of salinity and nutrients.
4. Determine the influence of different nutrient level on yields and growth and nutrient distribution in three cultivars .
5. Evaluate the production of Faba beans growing in hydroponics .

Chapter Two

Background

2.1 Hydroponic system

2.1.1Overview

Hydroponics system is a new approach had been applied in last years, which is mean production of plants in medium without soil (water), where nutrients are dissolved in water in order to supplied to crop (Diver 2006). Over the years hydroponics has been defined differently but all the definition of hydroponic synonymous with soil less culture, where plant cultivation in any solution contain nutrients. Although hydroponics is a popular topic in biology, the history of hydroponics is rarely considered over years. Many authors agree that the first use of hydroponics was The Hanging Gardens of Babylon, one of the seven wonders of the ancient world, (Resh 1990), In (1699) John Woodward who is English physician was considered as the first person to grow plants in water culture and so ,he published a scientific article about his experiments to test Helmont's theory that plant matter is formed entirely from water. (Hershey 1991). After that in the 1860s, German scientists Sachs (1887) and Knop developed nutrient solution methods, Then William Frederick Gericke (American plant physiologist), In 1929, reported use of solution culture to produce crops, not for research only. He called the technique "aquaculture" (Hershey1994) Later, Gericke (1937) considered the first one who called "hydroponics" in this name ,he state that the term aquaculture had been previously

defined as the growing of aquatic plants and animals, so it couldn't applied on hydroponics systems. (Hershey1994), Today, solution culture hydroponics is still an important research technique and is the method NASA scientists will use to grow plants in the space station, Commercially, solution culture hydroponics offers the advantage of producing pesticide-free vegetables as at Phytofarm of DeKalb, Illinois (Hershey1994). Hydroponics didn't limited on research in labs, it was extended to Institutions, and spread over the world. Nowadays hydroponics system became accessible to many people in Western Europe and is now used widely in the Netherlands for the commercial production of food, followed by Canada in this regard, in Arab country U,A,E considers number one in hydroponics plant production. In Palestine hydroponics Still confined in research, recently fresh green barley grass produced in many area of Palestine as fodder for Livestock. Hydroponics systems like any systems in the worlds, have advantages and dis advantages, but his advantage is more than disadvantages, it can be conclude in many points:- The advantages of this method include: Does not require soil. so it can be planting on the roofs or inside rooms, Higher yields due to minimal competition of plants and nutrients among roots. (Schoenstein, 1996). Soil nutrients are not diminished so crop rotation is unnecessary. reduces or eliminates soil borne weeds, diseases and parasites. Closed system means that pesticides and fertilizers are not washed into water table or streams. requiring small space. so it can use in roofs. And so The growth rate on a hydroponics plant is 30-50 percent faster than a soil plant, grown under the same conditions

(Haddad .et al.2009) .Finally Plants which grown hydroponically have increase in vitamins and minerals compared to plants grown in soil. (Skagg, 1996). While the disadvantage of the hydroponics : More expensive than traditional method of agriculture, because it needs construction and many equipments as pump, tubes, nozzles and usually timer . Need experience in preparing nutrient solution, peoples who are non chemist face difficulty in preparing kinds of nutrients solutions. compared to traditional method which need less knowledge. Since the systems need construction, hydroponics system application is more difficult than that of a traditional garden. Finally Diseases easily spread, where all plants share the same line or same large container.

2.1.2 Plants in Hydroponics

Many research have been conducted on plants grown in hydroponics systems, where it show that the growth rate on a hydroponics plant is 30-50 percent faster than a soil plant, grown under the same conditions (Haddad.et al.2009), according to (Schoenstein, 1996) this is due to minimal competition of plants and nutrients among roots. The aims to do research on plants in hydroponic, is to examine if that plants economically viable when grown in hydroponics. So that many plants were examined in hydroponics systems, one of that plants is tomato where (Alsaadi and Hattab 2012) conducted research about Effect of overlap between the sodium chloride and proline acid in bearing tomato plant.(Hassan .et al 2008) studied The effect of different concentrations of Calcium sulphate in some growth characteristics of shoot and root for six wheat cultivars,

(althalme,2012) studied *Begnonia purpurea* in hydroponic system in order to examine the effect of calcium level in nutritious solution in the growth of plants. its clearly that research in hydroponics systems is prefer than in soil because in hydroponics you can control environments of the roots horizons, in Palestine hydroponics Still confined in research ,recently Fresh green barley grass produced in many area of Palestine as fodder for Livestock.

2.2 Faba Beans

2.2.1 Overview

Faba bean (*Vicia faba* L.), also known as Faba bean, broad bean, horse bean or field bean, is a member of the Fabaceae family. Faba bean was one of the first crops domesticated with cultivation dating back to the early Neolithic age about 10 000 years ago, the main origin was in Middle East, the oldest remains were found in Jericho, from Jericho the species has spread to the worlds. (Cubero 1974) The evolution of Faba bean included adjustments of life-cycle, growth habit and pod dehiscence. Local selection occurred in various populations for seed size, seed color and degree of inbreeding (Bond 1976). During the 20th century, the importance of Faba bean declined due to mechanization of agriculture. Nevertheless, many important agronomic characters have been introduced into cultivars, including determinate growth habit, low anti-nutritional factor contents in the seed and disease resistance (Cubero 2011).

Faba bean is an important temperate zone grain legume and is used for food and feed worldwide. For food, it is used more commonly in Asia and

Africa .in Europe it is mainly used as animal feed (Torres et al. 2011). According to statics in 2010, the biggest producer of Faba beans was China with 1.4 million tons (Mt) followed by Ethiopia (0.6 Mt) and France (0.48 Mt).Total world production of Faba bean in 2010 was about 4 Mt from about 2.5 million hectares (Mha) with an average yield of about 1.6 t/ha which is about a ton less than the average yield of soybean (Faostat .2012).

In Palestine Faba beans grown for humans foods only , planting of Faba beans in Palestine dependent on rain water ,in some areas it grown under irrigation. Many cultivars used in Palestine ,the most cultivars used is Baladi then Artasi. in Palestine, during the past few years Fava bean yields and cultivation area have declined, mainly due to grower unwillingness, yield instability, difficulties in harvest and susceptibility to pests and diseases and growing other crops which are from their beliefs is more economically viable . According to Palestinian Central Bureau of Statistics (PCBS) "in 2oo8 The annual production of Faba bean in Palestine is very low and varies from year to year and from location to location, with a total production of about 339.5 tons cultivated on 399 ha. Beside it considers the source for human and animals food ,Faba beans play important role in crop rotation and soil improvement since it can fix a relatively large amount of nitrogen (60-250 kg/ha). Nitrogen fixation can occur by bacteria especially *Rhizobium leguminosarum* bacteria or other bacteria of the *Rhizobiaceae* (Torres et al. 2011).what make Faba beans environmentally acceptable choice for sustainable agriculture it is Low fertilizer, pesticide and fungicide requirement . In Palestine , Faba beans farmers divided into two

groups, one of them no adding N-fertilizers dependent on Nitrogen fixation, so that they depends on crop rotation where they grow legumes then grow wheat or other crops, other using artificial N because they depends on intensive agriculture in order to replenish the N that absorbed by plants.

2.2.2 Nutritional value of Faba beans

The nutritional value of Fava bean is traditionally back to to its high protein content , which ranges from 25% to 35% (Santidrian et al 1980) . this high content of protein is due to the ability to fix nitrogen, many kinds of proteins are found in Fava beans these proteins are globulins (60%), albumins (20%), glutelins (15%) and prolamine (Cubero and Mereno, 1982).its also a good source of sugar ,mineral and vitamins , the chemical analysis of legume reveals that there is proportion of carbohydrate which 50- 60 % of this content is starch. while the proportion of lipids is relatively low at about 1-2.5% with oleic and linoleic acid representing 75% of fat.(Larralde and Martinez.1991) .

The mineral content varies between 1-3.5%, being particularly rich in Calcium and iron .Additionally the amount of thiamin, tocopherols niacin and folic acid is high as compared with other grains, while vitamin C, riboflavine and other liposoluble vitamins low. The presence of some anti-nutritional factor such as lectins, tannins, protease inhibitor leads to some unfavorable effect on metabolism and nutritional utilization of this legumes in the food (Liener .1980).

Legume seeds are rich in many nutrients components such as ,dietary fiber, fatty acid ,and nutrients (vitamins and trace minerals). They are also rich source of many bioactive non-nutrients compounds including phenolic antioxidant (Shahidi et al., 2001). The mineral ,vitamins and others material that Faba beans include ,make its economic and medicals important so that it's necessary to study this plant in order to improve its quality, and to maintain this nutritional value .

2.2.3 Faba beans in Hydroponics systems

Many research have been conducted on many plants types in hydroponics system , Faba beans grown hydroponically as a part of research in order to improve Faba beans agriculture. So what is make Hydroponics prefer to researchers? In hydroponics system it is easy to control environments and roots zone this give accurate results compare to that in soil, now days people focused on hydroponics because it can grown in small places or on the roofs ,one of the aim of this research is to evaluate Fava bean grown hydroponically if it economically efficient .So research continue to select the crops which are economically efficient. One of this research done by Gal Tavori and his friends in 2004, They studied the influence of nitrate and salinity on Faba beans and Chickpea in hydroponics system and they conclude that increasing nitrate levels increase vegetative yields in the two plants (Tavori..et al.2004), khalafallah and his team in 2008 study the tolerant of seven Faba beans varieties to salinity in hydroponics systems (khalafallah,2008) Fatma Bulut and Şener Akıncı, in 2010 study the effect of salinity on growth and nutrients distribution in two cultivars of

Faba beans, they found one of the cultivars tolerant to salt where another is moderate tolerant (Bulut and Akıncı, 2010).

2.3 Salinity

2.3.1Overview

Salinity defined as the accumulation of salts (generally sodium chloride) in soil and water to levels that impact on human and natural recourses (e.g. plants, animals, aquatic ecosystems, water supplies, agriculture and infrastructure). Salinity consider one of the most stress factors which damage soil structure and cause reduction in yields, according to (FAO. 2000) statics, salinity has reached 19.5% and 2.1% in the irrigated field and dry agricultural areas respectively in the world . Salt are common and necessary component of soil ,and many salt components are essential plants nutrients like (nitrates and potassium ..etc)one of the source of salinity is irrigation water (Jan Kotuby-Amacher..et,al. 2000) , other source of soil salinity is Seawater intrusion into the groundwater, especially in coastal areas, and Dissolved salts added through irrigation and fertilization (Ibrahem, 2011). and it may be come from weathering of parent material . In Palestine ,many regions depends on intensive irrigated agriculture ,this method leads to accumulate salts in the soil , and so increasing the number of crops per year also increase the amount of irrigation water, thus further accelerating salt accumulation where annual precipitation is insufficient to leach salts which accumulate in the soil.

2.3.2 Measuring Salinity (EC).

Salinity is the measure of the concentration of dissolved (soluble) salts in water from all sources. As temperature is important in salinity calculation (usually measured at 25ºC), most EC meters have a built-in temperature compensation. This means that water samples can be measured quickly and accurately in the field.

TDS and TSS are measured by different processes but can be generally thought of as the same. Sodium Chloride (NaCl) is the dominant salt usually found in stream sampling; however other salts will also be registered with EC readings (e.g. carbonate and bi-carbonate salts, magnesium and calcium sulfates, potassium).

Usually, salinity is measured in units of electrical conductivity of a saturated soil paste extract (EC,) taken from the root zone of the plant as averaged over time and depth. Soil paste extracts are soil samples that are brought up to their water saturation points. Electrical conductivities(EC) can be measured in 1- deciSemiens per meter (dS m-l), 2- microsiemens per centimetre (μS·cm–1) 3- millisiemens per centimetre (mS·cm–1)

2.3.3. Effect of Salinity.

Salinity affect plants growth, where it affect yields, growth , nutrients distribution, and uptake. many research have been conducted on plants to show the effect of salinity and to improve crops in order to overcome the salt stress.

2.3.3.1 Effect of salinity on yields and growth

Many studies on the effect of salt stress on plants have focused on the growth and development of various parts of plants as well as nutrient change . As salinity levels in the soil increase, the plants face a difficulty in extracting the water from soil(*Jan Kotuby-Amacher*..et,al 2000) , this agree with (Munns ,2003) who stated that inhibition of plant growth under saline condition may either be due to decreasing the availability to water or increasing sodium chloride toxicity associated with increasing salinity .the effect of salinity depends on plants type and on the stage of growth of plants developments ,according to(Gaballah and Gomaa, 2004) the effect of salinity on plant growth is related to the stage of plant development at which salinity is imposed also , (Rahoades ,1990) agree with them when he reported that some plant are tolerant to salinity during germination ,but become more sensitive during emergence and early seedling stage . Many studies showed that the effect of salinity on plant growth and yields also relate to the concentration of salt, they conclude that when concentration of salts increased the harmful effect increase on the crops , salinity effect both vegetative growth and yields of plants , Table(2) show different concentration of salinity and its affect on crop plant , it conclude that when the salinity increase ,the harmful effect on the crops increase.

Table (1) Soil salinity classes and crop growth

Soil Salinity Class	Conductivity of the saturation Extract(ds/m)	Effect on Crop Plants
Non saline	0-2	Salinity effects negligible
Slightly saline	2-4	Yeilds of sensitive crops may be restricted
Moderately saline	4-8	Yeilds of many crops are restricted
Strongly saline	8-16	Only tolerant crops yield satisfactory
Very strongly saline	>16	Only afew tolerant crops yield satisfactory

Source (Abrol. et al .1988)

Salinity effect vegetative growth such as leaves, shoots, flowers, fruits and roots, studies on many plants show that salinity have adversely affect on vegetative growth, while Studies on plants of the family *Fabaceae* have suggested that salinity levels may stimulate root growth,(Mayber, 1999). Plants show many symptoms when it expose to salinity as wilting plants, drying and yellowing of the leaves. According to Neumann *et al* ,(1988) Na^+ toxicity symptoms can be recognized as leaf burn, necrotic spots, and limited expansion in sensitive plants when the soil contains approximately 0.25% Na^+ on a dry weight basis. When (Na^+)and (Cl^-) are taken up by the plants at high concentration, they accumulate in the tissue they may cause chlorosis (yellowing and curl), and if the situation continues the tissue reaches necrosis**.** Necrosis is where the tissue looses its vitality, turns brown, leaves curl and eventually the plant defoliates. Studies differed in analysis the reasons of adversely effect of salinity on plants. According to(Ronen .2006) Salinity affect on photosynthesis, and it has two major effects: First ,Leaf area is usually inversely related to salinity where surface

of the leaf area decreases. Due to salt accumulation in leaves, tissue is damaged. Second , Net CO_2 fixation per leaf area will decline, whereas respiration (during the dark) increases, which cause reduction in net CO_2 assimilation per unit of leaf area per day.

The accumulation of salts in the leaves cause premature aging, reduces the supply of plant parts with nutrients and products of carbon assimilation of the fastest-growing plant parts and thus impair the growth of the entire plant. In more sensitive genotypes salts accumulate more rapidly and because cells couldn't able to isolate the salt ions in vacuoles to the same extent as more tolerant genotypes, the leaves of more sensitive genotypes usually die faster (Munns, 2002).in other hand (Neumann, 1997) suggests that growth inhibition due to excessive salt concentration in the leaves reduces the volume of new leaf tissue in which excess salts can accumulate and therefore, in combination with the continuous accumulation of salts, it can lead to an increase in salt concentration in the tissue. Salinity affect yields, and it reduce yields in many plants type . Studies different in the reasons of why salinity reduce yields where some studies refer that to osmotic stress, other studies state that to toxicity of ions ,also yield losses due to osmotic stress can be very significant even before symptoms of toxicity on leaves become noticeable. Under the influence of salt stress growth of many species of vegetables is reduced, such as tomato (Romero-Aranda et al, 2001, Maggio et al, 2004), pepper, celery (De Pascale et al, 2003a,b) and peas (Maksimović et al, 2008, Maksimović et al, 2010).

2.3.3.2 Effect of Salinity on nutrients composition

Nutrients play important role in the reactions that occur in plants, and its play regulate role in osmotic pressure, sometimes working as activator or inhibitors of the enzyme, plants absorbed nutrients which are dissolved in water through the roots, then it move from root to stem through xylem . The high concentration of ions can disrupt the structure and function of cell membranes. Mineral nutrition of plants depends on the activity of membrane transporters which participate in the transfer of ions from the nutrient solution into the plant and regulate their distribution within and between cells (Marschner, 1995; Epstein and Bloom, 2005). Changes in membranes may finally lead to disturbances in chemical composition of cells and can therefore be displayed as symptoms of deficiency of some essential elements, similarly as it happens in the absence of salts (Grattan and Grieve, 1999). In the presence of salts some specific symptoms may be present, such as necrosis and burns of leaf edges because of the accumulation of Na^+ and Cl^- ions. (Wahome, 2001).According to many research salinity alter nutrient distribution in plants tissue and organs, and this depends mainly on salt concentration, (Levitt,1980) show that salinity decrease macro nutrients in plant tissue like Beans and peas. (Cordoivilla et al 1995) noted that Salinity causes nutritional disorders in plant which may lead to deficiencies of several nutrients and drastically increasing in Na^+ levels . (Gunes*et.*al, 1996) studied the effect of salinity on nutrients components to Pepper plant, he found that salinity increase (Na) and (Cl), but (N) and (K) decreased under salinity circumstances. According

to(Wang *et.al.*,1997) study on *Atriplexprostrata* he conclude that (Na) had been increased in plant which grow in salinity while the concentration of (K),(Ca) and (Mg) decreased. this results agree with (Chowdhury*et. al.*,1998) results, when studied the effect of salinity on sugar cane ,he found that addition of sodium chloride to plant led to increase (Na^+) and decreased the transmission rate of (K^+)to plant tissue. this relationship between (Na^+) and(K^+) absorption where(Na^+) inhibit absorption of(K^+) is may be due to compete on adsorption site, because of same number of charge ,also salinity affect on other nutrients distributions, this agree with (Street and Öpik,1984)study on maize (*Zea mays* L.)they noted that in saline environments, the K^+/Na^+ ratio decreases after inhibition of K^+ uptake by NaCl, On the other hand, nitrogen, K^+, Ca^{2+}, Mg^{2+} and Na^+ increased. according to(Abd-El-Ghaffer.*et.al.*1998) study that was conducted on Wheat plant, he state that exposure to salinity 3,6,9% of Sodium Chloride led to decrease plant content from elements like Phosphor ,Nitrogen ,Potassium, Calsium, Magnesium, and Ferrus while Sodium increased .similar observation found in chick pea (*Cicer arietinum* L.) where, salt treatment increased Na^+ and Cl^-, but K^+ decreased **(** Özcan et al 2000**)** ,on other hand Salinity stress increased Cu^{2+}, Zn^{2+}, and Mn in rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) varieties**(**Alpaslan et al 1998**)** On the other hand.the increase of sodium and calcium chloride salinity reduced Mg^{2+} in beet (*Beta vulgaris* L.) leaf but had no effect in tested leaves from five other vegetable crops.(Bernstein et al 1974). The results which carried out by (Al-Balawi,2001) indicated that the content

sodium (Na^+) increase in stem and root of Maize , and this increase Proportional with the increase of concentration of sodium chloride (NaCl) , while the content of stem and root from Potassium (K^+),Calcium (Ca^{2+}),Ferrous (Fe^{3+}),and Magnesium (Mg^{2+}) had been decreased compared with plant which didn't treated with Sodium Chloride . (Al-Dakheil,2002) explained that the Sodium(Na^+) content increased in Wheat plant which treated with 50, 100, 200 m mole of Sodium Chloride ,and this increase Proportional with the increase the concentration of sodium chloride in soil, while the content of Potassium (K^+),Calcium(Ca^{2+}), and Magnesium(Mg^{2+}) decreased compared with wheat not treated with salinity. Other example that happened between (Cl^-) and (NO_3^-)where Increase in uptake and accumulation of Cl^- is accompanied by a reduction in the concentration of NO_3^- in eggplant (Savvas and Lenz, 2000) and NO_3^- reduction in pea plants (Shahid et al, 2012). Many authors have attributed this reduction to the antagonism between Cl^- and NO_3^- (Bar et al, 1997) and those who explain it by reduced water uptake (Lea-Cox & Syvertsen, 1993). The rate of nitrate uptake or interactions between NO_3^- and Cl^- is associated with tolerance of examined plant species to salts; In addition, rate of nitrification of ammonia is often significantly reduced due to the large direct toxic effects of Cl^- and the total amount of salt on the activity of nitrifying bacteria (Stark and Firestone, 1995). Level of salinity doesn't affect necessarily the overall uptake of nitrogen by plants which may continue to accumulate nitrogen in the presence of excess salts despite a reduction in yield of dry matter. Other studies focused on nitrogen and protein contents, where (Langdale et al.

1973) when studied star grass reported that NaCl salinity increased the protein content in plants . Similar observations have been reported by (Helal et, al .1975) who found that salinization enhanced the incorporation of labeled N into protein, In another experiment, (Helal and Mengel 1979) found the reverse effect in young barley plants: the incorporation of labeled N into the protein fraction being impaired by NaCl salinity. Previous Studies, mostly based on nutrient uptake and interactions with salinity, affect growth periods of various plants under certain experimental conditions , it conclude that salinity may inhibit or promote nutrient uptake by different plant species. Other results show that the response of plant nutrient content to salinity changes with plant species and organs. The explanation of these result is may be due to Synergistic and antagonistic effects which may increase or decrease the intensity of nutrient uptake by plants for example, high concentrations of NaCl act antagonistically to the uptake of the other nutrients, such as K^+, Ca^{2+}, N, P (Cramer et al, 1991, Grattan and Grieve, 1999). According to (Ronen,2006**).** Ion imbalance is caused by interactions between the uptake of different ions, where one ion affects the uptake, transport or utilization of another. The imbalance can be caused by antagonism and competition(Ronen,2006**).** Part of this study is focused on salinity and its effect on growth and nutrients distribution in Faba beans which is classified as salt tolerant plants.

2.3.4 Salinity tolerance mechanisms

The mechanisms of salinity tolerance fall into three categories:

1-Tolerance to osmotic stress. The osmotic stress immediately reduces cell expansion in root tips and young leaves, and causes stomatal closure. A reduced response to the osmotic stress would result in greater leaf growth and stomatal conductance, but the resulting increased leaf area would benefit only plants that have sufficient soil water.

2- Na+ exclusion from leaf blades. Na+ exclusion by roots ensures that Na does not accumulate to toxic concentrations within leaves. A failure in Na+ exclusion manifests its toxic effect after days or weeks, depending on the species, and causes premature death of older leaves.

3- Tissue tolerance, i.e., tolerance of tissue to accumulated Na+, or in some species, to Cl−. Tolerance requires compartmentalization of Na+ and Cl− at the cellular and intracellular level to avoid toxic concentrations within the cytoplasm, especially in mesophyll cells in the leaf. Toxicity occurs with time, after leaf Na+ increases to high concentrations in the older leaves.

2.4 Fertigation

2.4.1 Overview

Fertigation is new word come as brief for fertilizers and irrigation , according to (*Kafkafia and Tarchitzky* 2011) Fertigation is providing crops in the fields with fertilizers through the irrigation water, and so (Hagin *et al.*, 2002) define Fertigation as a modern agro-technique, which give excellent opportunity to increase yield and decrease environmental pollution. Feritigation is an effective tool to control timing and the type of fertilizer needed according to the growth stage of the crop and the soil fertility status , when efficient irrigation system combined with nutrients

can be managed to obtain the maximum possible yield (Abedelraouf et al 2013). Human has been known the beneficial effect of adding mineral elements to soil in order to improve plant growth in agriculture, for more than 2000 years (Marcschner ,2012). Fertigation can be traced back to the mid 1800"s when plants were grown in water or sandy culture as a part of plants research in labs , soluble fertilizers solution were used in these experiments ,the first commonly used formula was Hoagland s solution and was developed by plant scientist at university of California in the 1930"s as apart of nutricultre experiment (Landis et al 2010) . Fertigation had spread after the invention of irrigation system(trickle irrigation, sprinkle irrigation…etc).After invention of cheap plastic pipes in 70's rapid implementation of trickle irrigation started .(*Kafkafia and Tarchitzky* 2011). Fertigation have many advantages,first, it allows accurate control of the concentration and balance of all nutrients that will plants have been provided , second, nutrient solution can be easily modified for any plant species or growth stage , third there is very low chance of over fertilization ,finally Fertigation solution are easy to monitor (Landis et. al .2010). Another advantage represented by Increased nutrient absorption by plants, where it provide the plants root directly with ready nutrients and so there is a reduction in fertilizer use and no fertilizer loss ,and it decrease exposure to disease . The disadvantage of Fertigation , its need nutrients injector for maximum effectiveness, well –designed systems , and automated irrigation system is essential to insure even fertilizer application , it need experience in dealing with fertilizers so ,excessive Fertigation can damage crops and pollute the environments, and so Nutrients and materials need in Fertigation is so expensive and need labor.

2.4.2 The role of Nutrients in plant

Most soil across the world do not require fertilizers, and it can provide plants with nutrients for a complete life cycle. However, people add artificial fertilizers to promote vigorous growth and increase yield. According (Barker and Pilbeam, 2007) Plants must obtain many nutrients from the growing media in order to grow these nutrients play important roles in plants life cycle ,these roles have been conclude by**:(** Stevens et al, 2002) in table no (2).which show the nutrients and there relative percent in plants and its functions.

Table number (2) nutrients and their function in plants

Name	Chemical symbols	Function in plant	Nutrient category
Nitrogen	N	Proteins, amino acids	Primary macronutrients
Phosphorus	P	Nucleic acid ,ATP	
Potassium	K	Catalyst,ion transport	
Calcium	Ca	Cell wall component	
Magnesium	Mg	Part of chlorophyll	Secondary macronutrients
Sulphur	S	Amino acids	
Boron	B	Cell wall component	Micronutrients
Chlorine	Cl	Photosynthesis reaction	
Copper	Cu	Component of enzyme	
Iron	Fe	Chlorophyll synthesis	
Manganese	Mn	Activates enzyme	
Molybdenum	Mo	Involve in N fixation	
Nickel	Ni	Component of enzyme	
Zinc	Zn	Activates enzyme	

Source:(Stevens et al ,2002)

2.4.3 Factor affecting ion uptake by root

Nutrients reach plants tissue through roots ,where plants uptake it from roots zone, the ion uptake characterized by. Selectivity in ion uptake , the ability of plants to absorb nutrients which is higher in its tissue than soils .

And ion uptake is also dependent on the genotype. Nevertheless there are many factors that affecting ion uptake by roots:-

2.4.3.1 Effect of PH

The PH play important role in ions uptake from external solution in horizons of plant roots ,According to (Marcschner,2012) the effects of PH on ions uptake can be divided into three categories : first ,effects of solution PH on the chemical species present in solution , Second ,effects of apoplasmic PH on the concentration of ions present in the apoplasm and third , influence the rhizosphere of PH for the proton electrochemical gradient and the driving force for proton –coupled solute transport , in addition solution pH can effect ion transport by protonation or deprotonation of amino-acid residue of transport proteins. The pH of the soil solution influences the availability of cations and anions for root uptake (White and Broadley,2009). (Alam ,1981) studied the effect of different PH levels of solution culture on rice growth and reported that growth was affected adversely at high PH . Optimal dry matter accumulation was noted at PH levels between 5.5 and 6.5 ,and maximum reduction in growth occurred at both PH 3.5 and 8.5 .and so, (Leidi, et, al,1991) studied the effect of high PH and salinity on wheat under NO_3 and NH_4 nutrition ,concentration of K+ in the shoots was reduced by increasing concentration of NaCl in the solution. A considerable decrease in K^+ was also noted at PH 9 and 100 mol-3 NaCl salinity. High NaCl concentration and high PH of the nutrient Solution resulted in an increase in Na^+ and Cl^- uptake. The length of root hairs of wheat growing in long Ashton nutrient

solution was affected by pH and the concentration Of Ca. Uptake of N, P, K, Ca ,Mg, Zn , Mn ,Cu and Fe were reduced by salinity and sodicity in Wheat (Padole, 1991). Its obviously from studies that PH have a large effect on nutrients uptake by every kind of plant which this include Faba beans.

2.4.3.2 Temperature

Its known that there is different in temperatures from region to another around the world and plants have been adapts to this different, Soil temperature affect plant growth whether it high or low, where it affect ions uptake ,(Clarkson et al,1988) showed that ion uptake is more temperature dependent than respiration, especially at temperature below 10C. Furthermore, at very high temperature s root respiration further increases where ion uptake decline.(Marschner,2012) conclude that in Maize ,at low root temperature (12 C) root growth and shoots decrease, and so the uptake rates of nitrate and potassium, as might be expected for a cold – sensitive plant species. In spinach seedlings, three temperatures of irrigation water (24, 26 and 28 °C) were evaluated during 8 weeks. Leaf length, leaf number and total fresh and dry biomass weights per plant were higher in plants grown at elevated temperatures, with optimum growth being recorded at 28 °C (Nxawe et al., 2009). In the high or in the low temperature, the nutrients distribution in plant will be affected because of the uptake of one ion on account other ions, (Miyasaka and Grunes,1990)give an example, Ca^{2+} and Mg^{2+} compared to uptake rates of K^{+} are often more effected by root zone temperature .In winter wheat,

increasing root zone temperature , cause increase in $K^+/(Ca^{2+}Mg^{2+})$ ratios in the shoots, which may cause deficiency in grazing beef cattle on winter wheat forage. In contrast to plants grown in solution culture, the roots of plants grown in soil must show difference for many immobile nutrients (White and Broadley, 2009). In plants that grown in the soil ,root temperature can affect the uptake of nutrients additionally through effects on root growth rate and root system morphology.

2.4.3.3 Interaction between Ions in the Rhizosphere

Its known that rhizosphere of plants roots contain many nutrients ,and these nutrients uptake by plants roots , Ions uptake depend on the properties of transporter and the concentration of other ions in the solution ,so that there is interaction between the ions found in the rhizosphere, there are many factor affecting the interaction between ions in the rhizosphere:-

2.4.3.3.1 Competition

As a result of availability of many nutrients in the rhizosphere competition between ions of the same valeney or diameter is common, nutrients can move from the rhizosphere solution to the cytoplasm across the plasma membrane of the root cells by transport proteins, where nutrients binding to carrier protein or entry through channel. According to (Marschner,2012) competition occurs particularly between ions with similar properties such as : chemical properties such as (valency) for example between the alkali cations such as, the competition between potassium (K^+) and rubidium (Rb^+), transport protein catalyzing K^+ transport across the plasma

membrane of root cells such as K channel ,cation channels, and proton – coupled K^+ symporters, don't differentiate between between K^+ and Rb^+ for transport (Pyo et al. 2010) .another example which happened between K^+ and Cs^+,(White and Broadley. 2000). studied *Arabidopsis thaliana* root where the major K channel in the root is relatively impermeable to Cs^+ ,which inhibit K^+ influx through this channel. Another distinct type of anion competition occurs between Chloride and Nitrate ,Chloride concentrations in plant tissues ,particularly in roots , can be reduced strongly by increasing nitrate availability (White and Broadley ,2001).

2.4.3.3.2 Cation-Anion Relation ships

Nutrients can be classified according to its charge to Cations which carry positive charge such as : Calcium, Magnesium, Potassium and Sodium , and Anions which carry negative charge such as: NO_3^-, PO_4^{2-}, SO_4^{2-}, etc.... The uptake of cations and anions occurs through different transport proteins, there for direct interactions between cations and anions for uptake are rare .However, (Marschner ,2012) state that the uptake of one nutrient can influence the uptake of another indirectly through effects on the membrane potential, the proton electrochemical gradients or via feedback regulation through plant growth or metabolism . Bear in one of his study state that replacement of nutrient by each other such as replace cations with anions, this may effect on the nutritional value of plants and in the economy of their production . (Bear,1950).

2.4.3.4 Plant Nutritional Status

The rate of uptake of nutrient at a given external concentration is often determined by plant growth rate which is through to affect the uptake of particular mineral nutrient through plant nutritional status (Walker et al,2001). Nutrient uptake responds rabidly to fluctuation in root nutrient concentrations and more slowly to long term changes in plant demand or external nutrient supply, according to(Britto and Kronzucker,2006) a rapid decrease in the net uptake of a nutrient by roots upon an abrupt increase in its external concentration can be the consequence of an increase in its cytosolic concentration and increased efflux across the plasma membrane. It is also observed that ,as the tissue concentration of particular mineral element increase ,its influx declines ,and vice versa. The uptake of NH_4^+ and NO_3^- is closely related to the N status of plants ,for example ,NH_4^+ uptake capacity is negatively correlated with concentration of NH_4^+ and certain amino acids such as glutamine and aspargine in the roots(Causin and Braneix,1993).

2.4.4 Effect of nutrient deficiency on plant

Plants need the right combination of nutrients to live, grow and reproduce. When plants suffer from malnutrition, they show symptoms of being unhealthy. Too little or too much of any one nutrient can cause problems. When Farmers used fertilizers they focused on fertilizers which contain macro nutrients such as N, P and K ,which it may be lack other micro elements such as Mo ,Fe ,Zn..etc. in this way plants will suffer from micro nutrient deficiency symptoms such as tip burn, chlorosis and necrosis Many

studies focused on the nutrients deficiency in plants ,and they showed the deficiency symptoms of macronutrients and micronutrients , according to (Wong ,2005), the location of the initial symptoms of nutrient deficiency generally occurs on either new or old leaves If symptoms appear on new leaves, the deficiencies could be from lack of iron, zinc, manganese, copper, boron, chlorine, calcium, or sulfur ,and if symptoms appear on old leaves ,the deficiency could be lack of Nitrogen, Phosphorus, Potassium and Magnesium. (Steven et al ,2002) mentioned that deficiencies of zinc, magnesium, iron, and manganese all typically cause yellowing of the tissue between leaf veins, sulfur and nitrogen deficiencies can cause yellowing between the leaf veins.

2.4.5 Effect of excess nutrient on plant

The global production of agricultural fertilizers increased from <10 million metric tonnes of N in 1950 to ca. 80 million metric tonnes in 1990, and its production is predicted by some authors to exceed 135 million metric tonnes of N by2030 (Vitousek et al., 1997) Some farmers lack experience in dealing with fertilizers which may lead to accumulation of nutrients in the soil that will effect on the growth of plants or death of plant Substantial additional N is applied to croplands in the form of animal manures for which regulatory standards are generally far less stringent than those applied to human sewage (Carpenter et al., 1998). A small but significant fraction of the total agricultural N applied to land is in excess of plant requirements for growth, and this surplus N may: accumulate in soils; move from the land into surface waters; migrate into ground water's; or

enter the atmosphere via ammonia volatilization and nitrous oxide production(Nolan et al., 1997, Carpenter et al., 1998). Human activities also have strong effects on the fluxes of P to the landscape. Large quantities of P minerals are mined and processed to create P-containing fertilizers .In many areas, P inputs from fertilizers and manures greatly exceed P outputs in farm produce, and P is thus accumulating yearly in the soil (Foy and Withers, 1995). (Kastori et al 1992) studied the effect of excess nutrients on plant growth and contents and they conclude that the concentration of soluble protein decreased when exposed to excess concentration of Zn,Pb,Cu,Cd, and it effect the number of stomata per leaf but size of stomata decreased. However the increase of nutrients may alter soil PH which affect nutrients uptake . Many studies mentioned that there is a relationship between ions , ions can effect on other ions. According to(Lewis, 1992; Britto and Kronzucker, 2002) Ammonium build-up can consequently have toxic effects, including the suppressed uptake of important cationic nutrients, such as K^+, Ca^{2+} and Mg^{2+} . Excess P reducing Fe, Mn and Zn uptake, which may affect plant growth where it causing deficiency symptoms of these nutrients to occur, another type of competition excess K can cause decrease in the uptake of Mg, and Ca which cause deficiency symptoms (McCauley et al ,2011), whereas excess N increase plants tall but decrease stem diameter. And plant transpiration increase (Jacobsen and Jasper, 1991). N toxicity may cause a burning effect under dry conditions, according to .(McCauley et al ,2011)plants that fertilized by excess NH_4 show reduce in growth especially under dry

conditions. That was for excess macro nutrients , but what about micronutrients, studies show there is few difference between deficiency and toxicity because the difference range is narrow for micronutrients (Brady and Weil, 1999) for example in B the toxicity ranges for various crops 10-200 ppm while deficiency range between50-200 ppm (Jones,1998). The symptoms of deficiency narrow to that of toxicity, where some nutrients compete with other nutrients so that it may cause deficiency, for example excess Cu will decrease Fe and other, metals in the plant tissue causing chlorosis and other Fe deficiency symptoms (Mengel and Kirkby, 2001).

It's obviously from the previous studies that ions uptake dependent on many factors that may inhibit or increase ions uptake by plants, this expected to be happened in this research especially in three times cooper solution and 25% cooper solution, and also didn't forget the effect of salinity on the uptake . Now why this study is important? And What does it differ from other studies? This study is important because studies and researches related to hydroponics in Palestine are still rare, We aim to educate people on this new system , in order to be application in Palestine , besides that the study focused on popular crops in Palestine, which is Faba beans where it usually planting in every house in Palestine.

This study differs from previous studies in many things: First, the concentration of NaCl was 4.68 and 7.8 ds/m^{-1} , whereas previous studies have relied on different concentrations , secondly, the conditions of the experiment was part of the circumstances, weather factors and natural

disparate momentarily terms of temperature, humidity and wind speed, while the previous studies, the conditions and weather factors have been controlled and fixed during the planting season, thirdly, the nutrient solution, which used Cooper solution full concentration in one of the section of the experiment and quarter Cooper solution in another section ,and 3times cooper solution, while other types of solutions have been used in previous studies such as solution Hoagland and Arnon solution and Steiner solution.

Chapter Three

Materials and Methods

3.1. Experimental program

The experiment had been divided into six groups, each group consist of three lines, each line contain four replicates from one of the three cultivars (Artasi, Baladi, Ispani).for each cultivars six experimental lines will be grown as:-

1- Group number one was the reference (control) contain water only without any addition of minerals .
2- Group number two was contain 25% cooper solution dissolved in 160 liters of water.
3- Group number three was contain 100% cooper solution (full plant requirements) dissolved in 160 liters of water.
4- Group number four was containing 3 times cooper solution (3 times plant requirements) dissolved in 160 liters of water.
5- Group number five was contain salinity (4.68ds/m-^{1} NaCl) dissolved in 160 liters of water.
6- Group number six was contain salinity (7.8 ds/m-^{1} NaCl) dissolved in 160 liters of water.

3.2 Experimental setup

In order to have hydroponics system, it need several key things: a reservoir to hold nutrient, a pump to circulate the nutrient, a growing tray and pots for the plants to be held in, and some sort of growing media PVC piping 6

inch .in this research the 6 inch pipe will be divided into pieces each pipe 2 meter, every pipe contains 4 plants, three cultivars of Fava bean used (Artasi, Baladi, and Isbani). Figure 2 shows the experimental setup

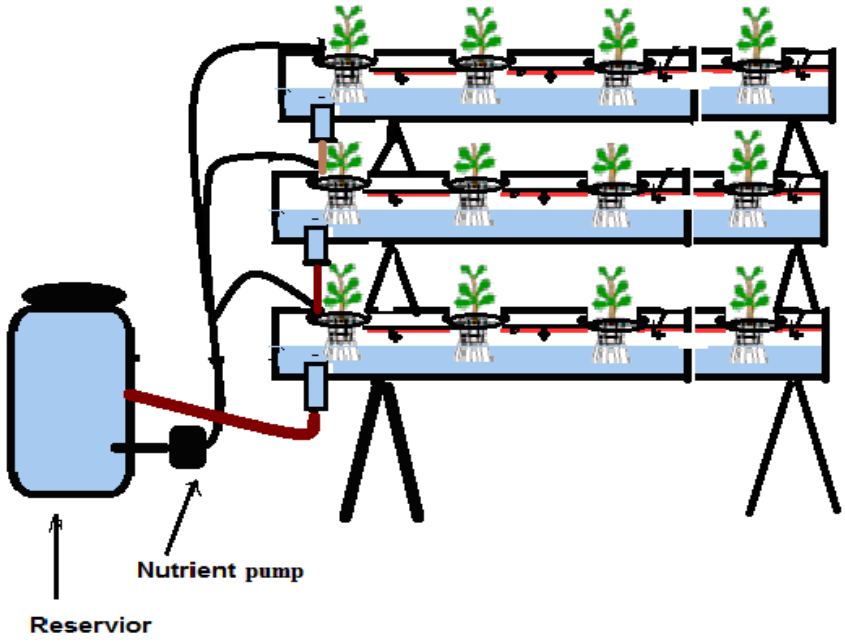

Figure 1: schematic of experimental setup

The hydroponics method of plant production means to suspend the plant roots in a solution of rich nutrients and oxygenated water. With these materials, roots will receive a high amount of oxygen this makes plants grow much faster, it needs some materials in order to make this system like :- rain gutters, plastic bucket ,pipes , plastic cup ,pumps. The pipe must be dark plastic, this makes penetration of light impossible ,so that green algae couldn't grow in it . After it have known the design of hydroponics system, then the system had constructed step by step as follow:-

Step 1:- It needs seven pipes 6 inches with long 4 meters , each one divided it to two meters.

Step 2:- Mark the plastic pipe on the site where will be grown ,in addition to that where drain holes and injector holes **,** the distance between two holes 40 cm and four plants in each pipe will be put.

Step 3 :-Using an instrument to cut the holes for each grow a site , then cut a hole on the bottom of the tube to put a drain in it to avoid rising of the solution to the top of pipe and to make the solution in recycling movements , Figure(2) illustrates that

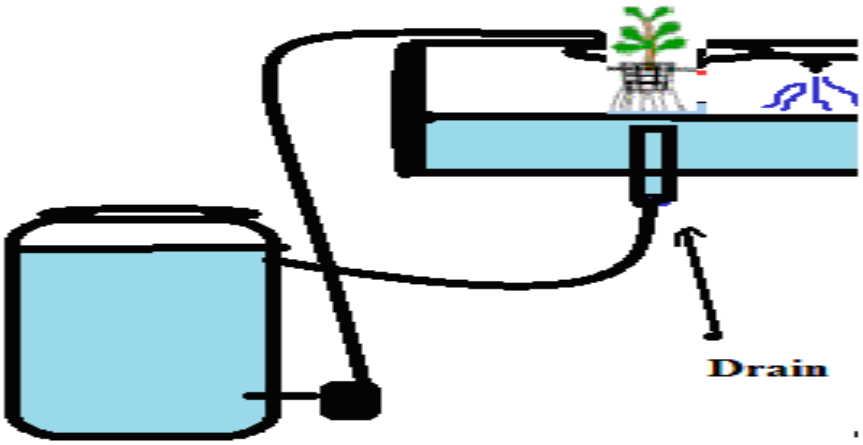

Figure 2: schematic for drain and reservoir

Step 4: internal spray lines provide with Nozzles will be put inside each pipe , in order to do this It needs Nozzles, 1/2 inches ,flexible ,polyethylene tubing or 1/2 inches PVC , the spray line should attached to the inside of the chamber with plastic " Zip Ties " and the end of spray lines with either a PVC end cap or silicone sealant.

Step 5:- Reservoir construction, in order to construct reservoir it need a bin , bucket made from plastic, the reservoir should be dark painting to avoid Growing of algae in it as mention before . external pump is connected to the reservoirs. to push nutrients to the pipes.

Step 6:- build the support structure from sawhorse kit, saw horse make a simple and inexpensive , there are many alternatives, available including using two PVC pipes in the same fashions, screw two dry wall , screws into the stand as shown to keep the chambers from rolling adjust their heights for proper drainage .

Step7:- the final step in constructing hydroponics system is to assemble the manifold. In this step the systems ready to put plants on it ,Figure 3 shows the final shape of the system after construction finish.

Figure 3: final shape of the experiment

3.3 Germination of Faba beans for experiment

Seeds of Faba beans must come from a popular supplier as research centers, but unfortunately it didn't available in such places because of few research was conducted on Faba bean cultivars in Palestine , so that Faba bean seeds of three cultivars were obtained from a local supplier and were taken to the experiment site in local farm in AL-Yamun village close to Jenen city. Seeds were manually cleaned from any foreign seeds or materials as possible and washed ,then put in water for 24 hours**.** Plastic trays were used to germinate Faba bean seeds. The trays used to have the dimensions of 20cm length X 10cm width X5cm height; seeds were planted in media for germination called Beetmoss in 10/2/2014 . Soon after that, seeds were soaked with water for few Seconds, the soaking of Faba bean seeds were repeated twice daily for 30 days, at the end of this period the Faba bean seedling reaches the height of 10 cm. then transferred into plastic pipes , Figure4 show one of the three cultivars put in a plastic tray for germination.

Figure 4: Fava bean cultivate in plastic trays

3.4 Preparation of solution

3.4.1 preparation of NaCl solution

NaCl solution prepared by dissolving 5 gram (GM) in one liter water in order to have concentration of 5ooo ppm which equalc7.8 ds/m-^{1} NaCl , and dissolved 3 grams NaCl in one liter water to have concentration of 3000 ppm which equal 4.68ds/m-^{1} NaCl.

3.4.2 Preparation nutrient solution

Preparing nutrient solutions are one of the most challenging part of hydroponics, because nutrient solution procedure tend to be difficult to a non chemist. There are many nutrient solution used in hydroponic systems ,such as Hoagland solution and cooper solution ..etc, in this research cooper solution had been chosen because of its nutrient composition .table 3show kinds of nutrient solution and its composition nutrition.

Table 3 Concentration ranges of essential mineral elements according to various authors

Nutrient	Hoagland & Arnon (1938)	Hewitt (1966)	Cooper (1979)	Steiner (1984)
	mg L^{-1}			
N	210	168	200-236	168
P	31	41	60	31
K	234	156	300	273
Ca	160	160	170-185	180
Mg	34	36	50	48
S	64	48	68	336
Fe	2.5	2.8	12	2-4
Cu	0.02	0.064	0.1	0.02
Zn	0.05	0.065	0.1	0.11
Mn	0.5	0.54	2.0	0.62
B	0.5	0.54	0.3	0.44
Mo	0.01	0.04	0.2	Not considered

Source : Cooper (1979)

Cooper solution is more commonly used in lotions Farms membranes nutrients. The table 4 shows the concentrations of elements in the nutrient solution, which is calculated on the basis of parts per million or else g / 1000 liters in of the solution

Table 4 : the concentrations of elements in the nutrient solution

Element	Symbol	Conc ppm
Nitrogen	N	200
Phosphorous	P	60
Kalium (Potassium)	K	300
Calcium	Ca	170
Magnesium	Mg	50
Ferrous (Iron)	Fe	12
Manganese	Mn	2
Copper	Cu	0,1
Zinc	Zn	0,1
Boron	B	0,3
Molybdenum	Mo	0,2
Sulfur	S	69

Source http://telc.tanta.edu.eg/hosting/pro11/containt/L5-3.htm

After the elements and its concentration have been known it needs to bring these elements, but the problem the nutrients cant find alone its apart of many compounds , Table 5 shows the compounds(salt)which cooper solution prepare and the required weights from each salt for the preparation of 1000 liters of the solution.

Table 5 compound that cooper solution prepare from.

Salts used	Molecular weight	Weight
$Ca(NO_3)_2$. $4H_2O$	236	1003
KNO_3	101	583
KH_2PO_4	136	263
$MgSO_4$. $7H_2O$	246,5	513
Fe-EDTA	367	79
$MnSO_4$. H_2O	169	601
H_3BO_3	62	107
$CuSO_4$. $5H_2O$	149,7	0.39
$(NH_4)_6Mo_7O_{24}.4H_2O$	1236	0,37
$ZnSO_4$. $7H_2O$	287,6	0,44

Source http://telc.tanta.edu.eg/hosting/pro11/containt/L5-3.htm

3.5 System Operation:

The plants were transferred to the pipes after 30 days from germination and put in tap water only for a few days in order to adapt with new environments Then the pipes have been discharged from the tap water, and prepared nutrient solutions were transferred to growth chambers (Line 1, Line 2, Line 3, Line 4, Line 5 and Line 6)respectively, and pumps were run three times for entirety 1.5 to 2 hours a day.

The pumps are running, which push the nutrient solutions to the pipes, which include plants, and the movement of the nutrient solutions constantly. This is important to prevent root rot, .when 10% of the water volume was spent due to transpirations and evaporation, the water replace again .Figure(5) shows the final shape of the system after operates it and transform plants to it.

Figure (5): the system after transfer plants

3.6 Field and lab measurement and analysis

3.6.1 Measurement of growth

Growth measurements had been taken after 30 days from planting in growth media and after transport to hydroponic system the measurements had been taken every 10 days , At the harvesting time, the growth parameters, plant height (PH), no of leaves (NL),leaves area(LA) , leaf fresh weight (LFW), leaf dry weight (LDW), stems fresh weight (SFW), stem dry weight (SDW) , root fresh weight (RFW) and root dry weight (RDW)of the seedlings were recorded using the methods of(Roberts *et al*.1993) and (Mackey and Neal1993), The separated parts of each plant were finally oven-dried at 75 °C for 12 h and kept in desiccators to constant weight until a dry weight determination**.**

3.6.2 Method of chemical analysis

The roots, leaves , stems and fruit of the faba bean were prepared for nutrient analyses ,Preparation methods of samples of plants and solutions had been adopted ICARDA, called (Dry Ashing), plant samples were Weighed 0.5 – 1.0 gm dry matter of plants (pods , leaves , stems or roots) and plant material were put in a 30 – 50 ml porcelain crucibles . porcelain crucibles were placed into a cooler muffle furnace, and temperature was increased gradually to 550 °C for 7 hours after attaining 550 °C, cold ash was dissolved in 10 ml portions 2 N HCl and mix with a plastic rod. After 15 – 20 minutes, brought to the volume 250-mL used distilled water, mixed thoroughly, allowed to stand for about 30 minutes, and used the supernatant. The aliquots were Analyzed for P by Colorimetry(ascorbic acid, ammonium molybdate, sulfuric acid 5N, potassium antimonyl titrate) . For Na by Flame Photometry, for Cl by titration with silver nitrate, and for others nutrients by ICP-MS, for S by Colorimetry (by Hydrochloric acid and Barium chloride) .

3.6.3 Chemicals and reagents:

- Hydrochloric acid 2M is used to prepare solutions from ash of plants.
- Nitrate reagent: HI93728-0, for measuring the concentration of nitrate in nutrient solution and plants
- Phosphate reagent :(ascorbic acid, ammonium moly date, sulfuric acid 5N, potassium antimonyl tartrate) had used to measuring the concentration of phosphate in nutrient solution and plants.

- Sulfate reagent :(25% $BaCl_2$, 1M HCl) had used to measuring the concentration of sulfates in nutrient solution and plants.
- Silver nitrate (0.0141M) and potassium dichromate (indicator): for measuring the concentration of chloride in nutrient solution and plants.

3.7. Data managements

Treatments in the experiment were arranged in a Completely Randomized Design (CRD), with six treatments, each treatments contain 3 pipes , each pipe had four replicate. The data were statistically analyzed using the one-way analysis of variance(Anova) to compare between the response of each variety to the five treatments. The means were compared by LSD at 5% using SPSS program version 21.

Chapter Four

Result and Discussion

The results are classified into three main parts, first, results show the impact of salinity and nutrient concentration on yields of the three cultivars of Faba beans, second, results show the effect of salinity and nutrients in the morphological and physical characteristics include the number leaves, plants height, leaves area and root length and so fresh and dry weight of whole plants ,third , result show the effect of nutrients and salinity on nutrients distribution in different parts of Faba beans. the result shown as follows

4.1 Yields

Statical analysis was conducted using one way ANOVA test, means were compared using LSD test at 0.05 probability level., test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines table 1-3 in appendix show ANOVA test for Baladi, Artasi and Isbani cultivars according to lines the output has a statistically significant difference between group means. so it need homogeneity test and mean separation . Total number of Pods influenced by different the concentration of Cooper solution and sodium chloride are presented in table(1) increasing concentration of cooper solution ,increase number of Pods in the three cultivars , this agree with(Badr and Abou El-Yazied 2007)when they studied tomato they found yields increased when the concentration of Fertigation increased , Figure show Artasi pods were

put in 100% cooper nutrient solution .while in line (6) the plant had been dying before it reach the flowering stage.

Figure (6): Artasi pods in 100% cooper solution .

In other hand, increasing sodium chloride decrease no of pods in line 3 compared to the reference ,this result agree with(Khalafallah, et ,al .2008) when studied seven varieties of Faba beans ,they found a significant decrease in the number of pods as salinity increased. While in line no 4 the plant had been dying in flowering stage and didn't produce Pods, table 4-10 in the appendix show there is no significant difference between cultivars in each line at ($p < 0.05$),.so no need for mean separation.

Table 6: Effect of different concentration of Cooper solution and Sodium Chloride on numbers of pods. Each value is mean of four replicates

line no	Artasi	Baladi	Isbani
line1	9 (a)*	11 (a)*	9.5 (a)*
line2	4.7 (b)*	7.5 (ab)*	7.25 (a)*
line3	1.25 (bc)*	1.5 (bc)*	1.25 (b)*
line4	0 (c)*	0 (c)*	0 (b)*
line5	1.25(bc)*	2 (bc)*	2.5 (b)*
line6	0 (c)*	0 (c)*	0 (b)*

Line 1: include 1 cooper solution , line 2 : 25% cooper solution, line 3: 3000 ppm NaCl, line 4: 5000 ppm NaCl , line 5 : water (control) , line 6 : 3 time cooper solution

*** significant between cultivars in different lines.**

4.2 Growth

Different growth measurements had been recorded such as shoot , root length ,Total leaf area for each plant , and fresh and dry weight of each plant parts of Faba beans, which treated by different concentration (3000 ppm and 5000 ppm) of NaCl and different concentration of cooper solution(25% , 100% , 300%) after 6 weeks from planting. Statical analysis had been conducted on vegetative growth . Table 1-3 in appendix show ANOVA test for Baladi, Artasi ,and Isbani cultivars according to lines the output has a statistically significant difference between group means.So it needs homogeneity test and mean separation .Table 4-9 in appendix show ANOVA test for cultivars in the same line , the results

show there is no significant difference between cultivars in lines at($p < 0.05$).

4.2.1 Number of leaves

Table 7 explains the effects of different concentration of cooper solution and sodium chloride on the number of leaves in three cultivars, the results show there is a significant increase in the number of leaves in line 1,and line2 compared to control ,this agree with (Cordivilla et al, 1995) result that the supply of nitrate would improve the vegetative growth of Vicia Faba. While there is a significant decrease in line 6 . Statistical analysis did not show significant differences in line 3,4 whether in the increase or decrease of leaves for plants exposed to salt stress, compared with the control plants, This agree with Raul et al. (2003), Jamil et al. (2005),results which conclude The harmful influence of salinity on leaf number, also increases with the increase in the concentration of sodium chloride.

Result show that there is no significant effect between cultivars in the same lines in except in line 2 and 5 , in line 2 Baladi and Asbani record the highest leaves number ,where Artasi record the lowest leaves numbers , in control lines (5) Asbani record the highest leaves number, while there is no significant effect between Baladi and Artasi.

Table 7: Effect of different concentration of Cooper solution and Sodium Chloride on numbers of leaves. Each value is mean of four replicates .

line no	Artasi	Baladi	Isbani
line1	155.5 a*	163 a*	158.7 a*
line2	76.25 b*	99.5 b*	117.5 a*
line3	29.25 b*	36.25 c*	32.25 bc*
line4	32.25 b*	29.25 c*	28.5 c*
line5	32 b*	35.5 c*	73 b*
line6	14 b*	11.5 c*	12 c*

*** significant between cultivars at different lines**

4.2.2 leaves area

Data presented in table (8)show the effect of different cooper solution and sodium chloride on leaves area of three cultivars .Results revealed that increasing cooper solution ,increasing leaves area significantly, the line one gave the highest significant value for leaves area to the three cultivars compared to the other treatment , while the lowest value of leaves area presented in line 6 ,there is no significant effect on leaves area compared to the three cultivars in line 1,2,6 which treated with cooper solution, Data showed that plants treated with two salinity levels showed significantly decreased in leaves area than control plants (line5) , where the leaves area decreased when the salinity levels increased ,this agree with (Ronen .2006) who found the same result results that Leaf area is usually inversely related to salinity ,and agree with (Raul et al., 2003; Netondo et al., 2004; Mathur et al., 2006) where they showed the affection of leaf area negatively by using different concentrations of NaCl .in other hand, results in the table

showed that there is no significant effect between cultivars except in control lines where Isbani record the highest leaves area.

Table 8: Effect of different concentration of Cooper solution and Sodium Chloride on leaves area . Each value is mean of four replicates

line no	Artasi (Cm^2)	Baladi (Cm^2)	Isbani (Cm^2)
line1	1118.5 a*	1025.25 a*	981.75 a*
line2	484.5 b*	529.5 b*	646 b*
line3	117.5 b*	148.75 c*	181.25 cd*
line4	120.25 b*	100 c*	112.25 d*
line5	202.25 b*	153.5 c*	368.5 c*
line6	28 b*	23 c*	24 d*

* significant between cultivars at different lines

4.2.3 Height of shoot

Table number (9) clearly shows that for all bean varieties studied, the height of shoot increased in line 1and 2 significantly compared to the control when treated with cooper solution ,while it decreased significantly in line 6 compared to control, data showed no significant effect between Isbani and Artasi in line1 and 2 ,but Baladi show significant between line 1 and 2 .However there is no significant effect on the height of the shoot between cultivars inside line 1 and 2. On another side addition of two concentration of sodium chloride decrease Height of shoot significantly in Artasi and Isbani in line 3 and 4 ,but in Baladi there is no significant effect between line 3 and 4. This agree with **(**Mahajan and Tuteja,2005) who reported that physiological effects of drought on plants were the reduction in vegetative growth, particularly shoot growth, and agree with(Beltagi,et al., 2006; Mustard and Renault, 2006) they notice a connection between

the decrease in plant length and the increase in the concentration of sodium chloride.

Table 9: Effect of different concentration of Cooper solution and Sodium Chloride on height of shoots . Each value is mean of four replicates .

line no	Artasi (cm)	Baladi (cm)	Isbani (cm)
line1	45.25 a*	46.75 a*	42.75 a*
line2	38.5 ab*	38.25 b*	38.75 a*
line3	24 cd*	24.45 c*	23.75 bc*
line4	21 de*	21.75 c*	19 c*
line5	31 bc*	27 c*	29 b*
line6	14.04 c*	13.25 d*	16.75 c*

*** significant between cultivars at different lines**

4.2.4 Root length

Significant variation in root length was observed in table (10) between lines compared to the control , the line (3) gave the highest significant value for root length to the three cultivars compared to the other treatment, while the line (6) show the lowest significant value , there is no significant different between line (1) and line (2),but there is significant different between cultivars in line(2),Isbani show the highest root length followed by Baladi and Artasi. Result show significant difference between Line(3) and(4) compared to control line(5) this agree with(Mayber.et al 1999). results that salinity levels may stimulate root growth. and this results disagree with (Yermiyahu,et al 1997) result that showed reduction in root elongation when increased sodium in the root medium. In line (3) there is a significant

different between cultivars, where Isbani show the highest root length and Baladi show the lowest root length.

Table 10: Effect of different concentration of Cooper solution and Sodium Chloride on roots length. Each value is mean of four replicates.

Line number	Artasi (cm)	Baladi (cm)	Isbani (cm)
line1	30.75 c*	32 b*	33.25 b*
line2	30.5 c*	32.25 b*	35.5 b*
line3	42.75 a*	30.5 b*	48.75 a*
line4	22.75 d*	21.75 c*	26.5 c*
line5	35.25 b*	40.75 a*	44.5 a*
line6	14.25 e *	16.25 d*	14 d*

*** significant between cultivars at different lines**

4.3 Fresh and dry weights

Statical analysis was conducted using one way ANOVA test, test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines ,table 10-12 in appendix show ANOVA test for, Artasi , Isbani and Baladi cultivars according to lines the output have a statistically significant difference between group means. So it need homogeneity test and mean separation**,** in table 13-16 in appendix which describe the mean value to the three cultivars in each lines, some result show there is a significant difference but others show there is no significant difference between cultivars in each line. Details of the result below.

4.3.1 Fresh and dry weights of roots

Data presented in tables (11,12) show the effect of different cooper nutrients solution and sodium chloride on fresh and dry weight of three

Fava beans cultivars .Results revealed that plants treated with cooper solution(line 1,2) show significant different in fresh and dry weight in all cultivars compared to control line (5) ,while there is no significant different between line (1)and(2), results show significant different in line(1)between cultivars in dry weight ,where Isbani recorded the highest dry weight and Baladi the lowest, but there is no significant different between Artasi and Baladi. Result show there is no significant effect of salinity on dry and fresh weight of three cultivars in line (3) compared to control line (5),and no significant different between cultivars in line (3), in line (5) result show significant different between cultivars ,where Isbani and Artasi recorded the highest fresh and dry weight .

Table 11: Effect of different concentration of Cooper solution and Sodium Chloride on fresh weight of roots. Each value is mean of four replicates .

Line number	Asbani (gm)	Baladi (gm)	Artasi (gm)
Line1	65.62 a *	40.99 a*	47.71 ab*
Line 2	59.49 a *	33.04 a*	59.78 a*
Line3	14.22 b *	9.11 b*	10.88 b*
Line5	12.19 b*	4.96 b*	11.38 b*

*** significant between cultivars at different lines**

Table 12: Effect of different concentration of Cooper solution and Sodium Chloride on dry weight of roots. Each value is mean of four replicates .

Line number	Asbani (gm)	Baladi (gm)	Artasi (gm)
Line1	8.55 (a)*	6.56 (a)*	7.21 (a)*
Line 2	7.82 (a)*	6.17 (a)*	6.78 (a)*
Line3	1.27 (b)*	0.93 (b)*	1.01 (b)*
Line5	1.67 (b)*	0.7 (b)*	1.47 (b)*

*** significant between cultivars at different lines**

4.3.2 Fresh and dry weights of shoot

Tables number (13,14)show the effect of different concentration cooper solution on fresh and dry weight of shoots ,the result show increasing in fresh and dry weight of shoots when increasing cooper solution, but the different not significant between line(1,2) which treated by 1 cooper and 25% cooper respectively . But when compared to control line 5, Line (1)and(2) show significant difference ,no significant different between cultivars inside line (1) and (2) found . In line (3) which treated with 4.68ds/m-^{1} NaCl ,no significant effect on the fresh and dry weight of the three cultivars ,compared to control line(5), this agree with (Lauter and Munns, 1987),on Chickpeas , and Faba bean (Vicia faba) (Yousef and Sprent, 1983; Zahran and Sprent, 1986) Salinity has been reported to reduce shoot and root weights in Inside the line no significant different between cultivars. Line 5 show significant different between cultivars between Artasi and Asbani from side and Baladi in other side.

Table 13: Effect of different concentration of Cooper solution and Sodium Chloride on fresh weight of shoots. Each value is mean of four replicates .

Line number	Asbani (gm)	Baladi (gm)	Artasi (gm)
Line1	69.37 (a)*	57.94 (a)*	73.3 (a)*
Line 2	51.12 (a)*	54.74 (a)*	53.02 (a)*
Line3	11.39 (b)*	8.51 (b)*	10.94 (b)*
Line5	7.94 (b)*	4.11 (b)*	8.43 (b)*

*** significant between cultivars at different lines.**

Table 14: Effect of different concentration of Cooper solution and Sodium Chloride on dry weight of shoots. Each value is mean of four replicates .

Line number	Asbani (gm)	Baladi (gm)	Artasi (gm)
Line1	17.49 (a)*	15.23 (a)*	18.66 (a)*
Line 2	12.43 (a)*	13.95 (a)*	14.62 (a)*
Line3	1.33 (b)*	0.54 (b)*	0.84 (b)*
Line5	1.55 (b)*	0.83 (b)*	1.53 (b)*

***significant between cultivars at different lines**

4.3.3 Fresh and dry weights of leaves

Data presented in tables (15,16) show significant effect of two concentration cooper solution in line (1) and(2) compared to control line (5), the result show increasing in fresh and dry weight of shoots but not significant, its clearly that there is no significant different between cultivars in the two lines (1,2), in line (3) there is no significant effect of salinity on fresh and dry weight of leaves compared to control line(5), this result disagree with Hu *et al*., when he studied maize plant ,he found that the shoot fresh weight grown under salinity were reduced by about 50%

compared to the control, and in another result Mahajan and Tuteja reported that physiological effects of drought on plants were the reduction in vegetative growth, inside the line(3) there is a significant different between cultivars in fresh weight , where Asbani recorded the highest fresh weight of leaves ,while there is no significant different between Artasi and Baladi and this the same result for dry weight of leaves, where Asbani recorded the highest fresh weight of while there is no significant different between Artasi and Baladi ,in line (5) there is a significant different between cultivars in fresh weight only , where Asbani and Artasi recorded the highest fresh weight ,and Baladi recorded the lowest fresh weight.

Table 15 : Effect of different concentration of Cooper solution and Sodium Chloride on fresh weight of leaves. Each value is mean of four replicate.

Line number	Isbani (gm)	Baladi (gm)	Artasi (gm)
Line1	44.52(a)*	41.04(a)*	64.21(a)*
Line 2	34.82(a)*	30.64 (a)*	60.57(a)*
Line3	5.91(b)*	3.26(b)*	3.92 (b)*
Line5	5.41(b)*	2.38 (b)*	5.34 (b)*

***significant between cultivars at different lines**

Table 16 : Effect of different concentration of Cooper solution and Sodium Chloride on dry weight of leaves. Each value is mean of four replicate.

Line number	Isbani (gm)	Baladi (gm)	Artasi (gm)
Line1	11.08(a)*	9.74(a)*	13.97(a)*
Line 2	7.22(a)*	8.64(a)*	11.91(a)*
Line3	0.89(b)*	0.54(b)*	0.58 (b)*
Line5	0.99(b)*	0.43(b)*	0.96 (b)*

*** significant between cultivars at different lines**

4.3.4 Fresh and dry weights of pods

Data presented in tables (17,18) show that there is a significant effect in line (1)and(2) in the three cultivars compared to control line , there is no significant different between line (1)and (2) which treated by two concentration of cooper solution, according to cultivars statically no significant different found. In line 3 which treated by4.68ds/m-^{1} NaCl there is no significant different on fresh and dry weight of pods ,compared to control line, while there is a significant different between cultivars in dry weight only ,where Isbani significantly different from Baladi ,but Artasi hadn't show significant different compared to Baladi and Isbani.

Table 17: Effect of different concentration of Cooper solution and Sodium Chloride on fresh weight of Pods. Each value is mean of four replicates

Line number	Isbani (gm)	Baladi (gm)	Artasi (gm)
Line1	57.12(a)*	39.68(a)*	57.13(a)*
Line 2	46.78(a)*	43.39(a)*	46.87(a)*
Line3	2.93(b)*	2.23(b)*	2.11(b)*
Line5	1.89 (b)*	1.87 (b)*	3.43(b)*

*** significant between cultivars at different lines**

Table 18: Effect of different concentration of Cooper solution and Sodium Chloride on dry weight of Pods. Each value is mean of four replicates

Line number	Isbani (gm)	Baladi (gm)	Artasi (gm)
Line1	9.70(a)*	7.18(ab)*	9.23(a)*
Line 2	7.39(a)*	8.91(a)*	6.98(a)*
Line3	0.44(b)*	0.23(b)*	0.34(b)*
Line5	0.39(b)*	0.33(ab)*	0.48(b)*

*** significant between cultivars at different lines**

4.4 Nutrient Distribution

The concentration of different nutrients, namely, Potassium, Copper, Sodium, Calcium, Iron, Zinc, magnesium, Nitrate, Sulphate, phosphate, Chloride and Manganese in broad bean plants were determined. Statical analysis was conducted using one way ANOVA test, test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines. Table 22 in appendix show ANOVA test for, Artasi , Isbani and Baladi cultivars according to plants parts the output have a statistically significant difference between group means in some nutrients.. So it need homogeneity test and mean separation**,** in table 17-19 in appendix which describe the mean value to the three cultivars in each lines, some result show there is a significant difference but others show there is no significant difference between cultivars in each line. Details of the result below.

4.4.1 Nitrate

Table (19) shows average mean of nitrate in all parts of bean plants at different lines and describes the variation of average mean of nitrate in all parts of beans plants, the result show significant increase in line 1and 2 , compared to control line (line 5), there is no significant difference between cultivars inside line 1 and 2,in line 3 the result show increase in nitrate concentration compared to control line, but this increase not significant.

Table (19) Average mean content of Nitrate in all parts of Faba beans at different lines, Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	51.46(a)*	50.56(a)*	54.38(a)*
Line 2	28.84(b)*	29.10(b)*	30.39(b)*
Line 3	18.27(b)*	18.42(bc)*	19.10(bc)*
Line 5	14.81(b)*	10.51(c)*	11.50(c)*

*** significant between cultivars at different lines .**

Table (20) describe average mean content of Nitrate in whole plants , the result revealed that Nitrate increase in the leaves and roots in ,but decrease in shoots and pods, Isbani cultivars show decrease in Nitrate content from the roots to the pods, where Baladi increase in the roots and leaves, but decrease in shoots and pods ,while Artasi show significant increase in leaves, and pods ,but decrease in roots and shoots compared to other cultivars.

Table (20) Average mean content of Nitrate in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Plants part	Artasi(ppm)	Baladi (ppm)	Isbani (ppm)
Pods	26.70	23.33	25.27
Leaves	39.15	32.98	27.60
Shoots	23.46	20.58	30.20
Roots	24.05	31.89	32.28

4.4.2 Sulphate

The result in Table (21) show the average content of Sulphate in all parts of Faba beans at different lines, the result show significant increase in line 1and 2, compared to control line (line 5), there is no significant difference

between cultivars inside line 1 and 2,in line 3 the result show increase in nitrate concentration compared to control line, in line 3 the result show increase in Sulphate concentration compared to control line, but this increase not significant.

Table (21) Average mean content of Sulphate in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Line number	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	51.30(a)*	55.80(a)*	33.56(ab)*
Line 2	25.96(ab)*	30.04(ab)*	37.06(a)*
Line 3	17.10(ab)*	16.75(b)*	21.75(ab)*
Line 5	13.46(b)*	13.25(b)*	13.81(b)*

*** Significant between cultivars at different lines**

Table(22) describe average mean content of Sulphate in whole plants, the result revealed that in the root concentration of Sulphate recorded the highest concentration ,then the concentration decrease in the shoots, leaves, pods In descending. In cultivars, in Artasi the Sulphate concentration increase in roots compared to other cultivars, but in other parts of plants it show decrease compared to other two cultivars. While Baladi show increase the Sulphate in shoots only, while it decrease in others parts compared to the other two cultivars. In Isbani the increase were in leaves and pods ,and decrease in roots and shoots compared to other two cultivars.

Table (22) Average mean content of Sulphate in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Plants parts	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	17.09	19.74	22.54
Leaves	21.04	22.75	23.58
Shoots	24.07	28.78	25.03
Roots	45.61	44.57	35.06

4.4.3 Phosphate

The result in Table (23) show the average content of phosphate in all parts of Faba beans at different lines, the result show significant increase in line 1and 2 , compared to control line (line 5), there is no significant difference between cultivars inside line 1 and 2,in line 3 the result show increase in phosphate concentration compared to control line, in line 3 the result show increase in phosphate concentration compared to control line, but this increase not significant.

Table (23) Average mean content of Phosphate in all parts of Faba beans at different lines .each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	29.08(a)*	30.77(a)*	32.44(a)*
Line 2	9.85(b)*	10.87(b)*	11.24(b)*
Line 3	4.92(bc)*	4.78(bc)*	5.59(bc)*
Line 5	1.54(b)*	1.28(c)*	1.25(c)*

***Significant between cultivars at different lines .**

Table(24) describe average mean content of phosphate in whole plants , the result revealed that there is no significant different between plants parts .it show that phosphate found to increase in the roots and the pods of the three

cultivars, while it decrease in shoots and leaves. No significant difference found between cultivars parts.

Table (24) Average content of phosphate in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Plants part	Artasi	Baladi	Isbani
Pods	12.50	12.37	15.33
Leaves	8.67	10.06	9.73
Shoots	9.85	11.21	11.07
Roots	14.37	14.08	14.39

4.4.4 Potassium

The result in Table (25) show the average content of Potassium in all parts of Faba beans at different lines, the result show significant increase in line (1)and(2) , compared to control line (line 5),where there is no significant different between line (1) and (2),while there is no significant difference between cultivars inside line 1 and 2,where Baladi record the highest mean content which is statically not significant . In line 3 the result show decrease in Potassium concentration compared to control line, but this decrease statically not significant.

Table (25) Average mean content of Potassium in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	84.61(a)*	102.05(a)*	89.17(a)*
Line 2	56.04(ab)*	62.04(ab)*	59.60(ab)*
Line 3	26.47(b)*	24.32(b)*	36.90(b)*
Line 5	54.08(ab)*	52.88(b)*	52.13(b)*

***Significant between cultivars at different lines**

Table(26) describe average mean content of Potassium in whole plants, result show that there is no significant different between plants parts in the content of Potassium and no significant different between cultivars, the result revealed that in the Potassium concentration increase in pods of Artasi and Isbani, while it decrease in Baladi pods, there is slightly increase in Potassium content in leaves ,shoots, and roots of Baladi compared to Artasi and Isbani, slightly decrease was found in Artasi cultivars in leaves, shoots and roots compared to Isbani and Baladi.

Table (26) Average content of Potassium in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	60.86	41.77	63.93
Leaves	59.77	68.88	63.17
Shoots	47.93	61.64	55.34
Roots	52.64	69.02	55.72

4.4.5 Sodium

The result in Table (27) show the average content of Sodium in all parts of Faba beans at different lines, the result show significant increase in line (3), compared to others lines , there is no significant difference between cultivars inside lines, result show increase in Sodium concentration in Isbani compared to Baladi and Artasi but its not significant. Result show significant decrease in line (1) and (2) when compared to line (3),Concentration of Sodium increase slightly in Baladi in line (1)and (2) compared to Artasi and Isbani. Where the increase statically not significant.

Table (27) Average mean content of Sodium in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Line number	Artasi	Baladi	Isbani
Line 1	7.67(b)*	12.51(b)*	9.51(b)*
Line 2	17.90(b)*	21.22(b)*	16.37(b)*
Line 3	91.26(a)*	96.67(a)*	112.10(a)*
Line 5	43.69(ab)*	42.92(ab)*	41.88(b)*

***Significant between cultivars at different lines**

Table (28) show average mean content of Sodium in whole plants , the result revealed that there is no significant difference between plants parts and between cultivars ,the lowest sodium content was in the pods, where the sodium content was in this order Isbani >Baladi>Artasi, while the highest sodium content was in the root where Isbani>Baladi>Artasi .

Table (28) Average content of Sodium in all parts of Faba beans at different lines value is a mean of four replicates .

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	12.24	14.16	20.97
Leaves	46.35	51.60	46.02
Shoots	56.66	53.62	53.47
Roots	45.28	53.95	59.42

4.4.6 Magnesium

The result in Table (29) show the average content of Magnesium in all parts of Faba beans at different lines, the result show that there is no significant difference between lines, and it show statically there is no significant difference between cultivars in the lines. Magnesium in Baladi recorded increase in lines compared to the two cultivars where it

Line1>line 5>line2>line3.where result in Isbani show close to each other with slightly decrease in line3,and increase in line1,while Artasi increase slightly in line1and decrease slightly in line3.Based on these results, salinity decrease magnesium in the three cultivars.

Table (29) Average mean content of Magnesium in all parts of Faba beans at different lines. Each value is mean of four replicate.

	Cultivars		
Line	Artasi (ppm	Baladi (ppm)	Isbani (ppm)
Line 1	13.65	26.56	13.32
Line 2	11.23	12.90	13.22
Line 3	8.68	11.37	9.47
Line 5	10.16	16.30	13.23

Result in table (30) show there is a significant different between plants part in Artasi and Isbani ,where in Artasi leaves recorded the highest value followed by shoots, roots, and pods, while in Isbani magnesium content recorded highest value in roots and leaves, then shoots and pods where there is no significant effect between it. However ,result show Statically there is no significant different between plants part of Baladi, where it show increase in leaves and decrease in other parts ,in this order leaves>roots>shoots>pods.

Table (30) Average content of Magnesium in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	5.40(c)**	14.12	6.59(b)**
Leaves	16.21(a)**	22.96	21.50(a)**
Shoots	12.24(ab)**	14.92	4.80(b)**
Roots	9.87(bc)**	15.13	16.35(a)**

***significant between plants part in each cultivars**

4.4.7 Chloride

Table (31) show the average content of Chloride in all parts of Faba beans at different lines, the result show that there is a significant increase in line (3),compared to others lines, the order of lines was line3>line5>line2>line1.But there is no significant difference between cultivars inside lines, result in line3 show increase in Chloride concentration in Isbani compared to Baladi and Artasi but its not significant the order was Isbani>Baladi>Artasi .in others lines the different between cultivars was slightly, Result show significant decrease in line (1) and (2) when compared to line (3) ,Concentration of Chloride increase slightly in Baladi in line (1)and (2) compared to Artasi and Isbani. Where the increase statically not significant.

Table (31) Average mean content of Chloride in all parts of Faba beans at different lines. Each value is a mean of four replicate.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	8.07(b)*	13.08(b)*	10.93(b)*
Line 2	19.00(b)*	19.67(b)*	18.23(b)*
Line 3	92.13(a)*	99.15(a)*	114.12(a)*
Line 5	45.03(ab)*	45.32(ab)*	44.08(b)*

***significant between cultivars at differents lines .**

Result in table(32) statically show there is no significant different between plants parts in all cultivars, but result show increase in shoots of Baladi and Artasi, the concentration of chloride in leaves and roots close to each other between cultivars , there is a decrease in pods of two cultivars. In Isbani increase found in roots and decrease in other parts in this order roots>shoots>leaves>pods.

Table (32) Average content of Chloride in all parts of Faba beans at different lines .Each value is a mean of four replicates.

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	12.04	15.01	21.84
Leaves	48.08	54.46	48.33
Shoots	57.76	55.44	56.06
Roots	46.36	52.32	61.13

4.4.8 Copper

The result in Table (33) show the average content of Copper in all parts of Faba beans at different lines, statically there is no significant different between lines, slightly increase was found in this order line1>line3>line2>line5,result show there is no significant difference

between cultivars in the lines, nevertheless there is a different in line(1), where it was in this order Baladi>Isbani>Artasi. In Line(3),result show slightly increase in Copper content compared to control line(5).

Table (33) Average mean content of Copper in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	0.068	0.090	0.089
Line 2	0.053	0.063	0.065
Line 3	0.066	0.063	0.066]
Line 5	0.0025	0.0077	0.0031

Result in table (34) show average mean content in all parts of Faba beans, the result show significant increase in roots of all cultivars ,compared to other parts .after roots, it's was found that Copper accumulate in leaves, statically there is no difference between leaves and roots in the three cultivars, shoots in Baladi and Isbani show there is no significant difference between shoot and leaves, while Artasi show significant difference between leaves and shoots. Pods in the three cultivars were found the lowest Copper content compared to other parts, based on these result the order of Copper content were Roots>Leaves> Shoots>Pods , Statically there is no significant difference between cultivars according to plant parts .

Table (34) Average mean content of Copper in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	0.021(b)**	0.013(b)**	0.021(b)**
Leaves	0.047(ab)**	0.041(ab)**	0.038(ab)**
Shoots	0.010(b)**	0.033(ab)**	0.036(ab)**
Roots	0.112(a)**	0.137(a)**	0.126(a)**

****Significant between plants part in each cultivars**

4.4.9 Calcium

The result in Table(35) show the average content of Calcium in all parts of Faba beans at different lines, the result show .There is no significant different between lines. However, in line 1and 2 show decrease ,when compared to control line ,where in line 1 there is no significant different between cultivars ,but there is slightly increase in Baladi compared to others two cultivars, while result in line 2 show increase in Artasi compared to others cultivars. Result revealed that in line3 increase Calcium concentration in Isbani and Baladi ,but decrease in Artasi, based on these results , it show statically there is no significant different between cultivars.

Table (35) Average mean content of Calcium in all parts of Faba beans at different lines .Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	49.77	50.65	33.94
Line 2	106.77	61.76	55.91
Line 3	88.66	131.48	148.83
Line 5	222.24	173.30	127.89

Table number (36) show average content in all different parts of Faba beans, the result show there is no significant different between cultivars in the plant parts ,while there is a significant different between plants part of each cultivars ,where leaves show the highest calcium content compared to other parts. Baladi show highest calcium content than other cultivars, result show there is no significant different between shoots and roots in the three cultivars, Pods in the three cultivars show the lowest calcium content compared to other cultivars.

Table (36) Average content of Calcium in all parts of Faba beans at different lines. Each value is a mean of four replicates

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	21.28(b)**	20.51(b)**	28.95(b)**
Leaves	189.62(a)**	203.41(a)**	136.68(a)**
Shoots	132.44(ab)**	62.97(ab)**	86.66(ab)**
Roots	124.10(ab)**	130.29(ab)**	114.27(ab)**

****Significant between plants part in each cultivars .**

4.4.11 Iron

The result in Table (37) show the average content of Iron in all parts of Faba beans at different lines, the results show there is no significant different between cultivars In the lines, and it show there is no significant different between lines, although there is increase in line 1in all cultivars compared to other lines, but this increase not significant. in line 2 there is decrease compared to line 1,in line 3 there is slightly decrease compared to control line(5).

Table (37) Average mean content of Iron in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	1.78	2.62	2.41
Line 2	1.07	1. 74	1.47
Line 3	1.34	1.19	1.77
Line 5	1.37	1.26	1.55

Table (38) show the average mean content of iron in different plant parts, the result show that there is no significant different between cultivars in each parts, while there is a significant different between parts in each cultivars, where there is a significant different between roots and others parts ,roots in the three cultivars had the highest iron content ,result show there is no significant different between pods ,leaves and shoots. Pods show the lowest iron content .

Table (38) Average content of Iron in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	0.18(b)**	0.15(b)**	0.22(b)**
Leaves	1.07(b)**	1.20(b)**	1.43(b)**
Shoots	0.74(b)**	0.86(b)**	0.80(b)**
Roots	3.59(a)**	4.60(a)**	4.75(a)**

****Significant between plants part in each cultivars .**

4.4.12 Zinc

The result in Table (39) show the average content of Zinc in all parts of Faba beans at different lines, the result show there is no Significant different between cultivars in each line, while there is a significant different

between lines in the content of zinc, where line 1 recorded the highest content of zinc in the three cultivars ,where Baladi>Isbani>Artasi in zinc content ,generally there is no significant different between line 2, 3 ,and line 5, in line 3 the result show slightly increase in Artasi and Isbani , and decrease in Baladi when compared to the line 5.based on these result the order of zinc content was line1>line 2>line3>line 5.

Table (39) Average mean content of Zinc in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	0.166(a)*	0.198(a)*	0.169(a)*
Line 2	0.071(b)*	0.051(b)*	0.092(b)*
Line 3	0.125(ab)*	0.039(b)*	0.076(b)*
Line 5	0.049(b)*	0.074(ab)*	0.066(b)*

***Significant between cultivars at different lines .**

Result in table (40) show the average content of zinc in the parts of three cultivars, where result show there is no significant different between cultivars in each part and so ,there is no significant different between plants parts in each cultivars ,but there is slightly increase in the roots and leaves ,where it statically not significant.

Table (40) Average content of Zinc in all parts of Faba beans at different lines. Each value is a mean of four replicates

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	0.058	0.088	0.105
Leaves	0.167	0.074	0.099
Shoots	0.080	0.099	0.089
Roots	0.106	0.101	0.111

4.4.12 Manganese

The result in table (41) show the average content of Manganese in all parts of Faba beans at different lines, the result show significant increase in line(1)compared to others lines ,where the concentration of Manganese was(line1>line2>line3>line5). Result show there is significant different between line 1and other lines. Where the manganese content in Baladi recorded the highest value, but statically there is no significant different between cultivars in each line,in line 3 the result show that there is increase in manganese content of the whole plants compared to control line(5),which lead that salinity cause increase in manganese content ,but this increase not significant.

Table (41) Average mean content of Manganese in all parts of Faba beans at different lines, Each Value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	0.41(a)*	0.87(a)*	0.44(a)*
Line 2	0.14(b)*	0.30(b)*	0.14(b)*
Line 3	0.12(b)*	0.27(b)*	0.12(b)*
Line 5	0.064(b)*	0.063(b)*	0.066(b)*

***Significant between cultivars at different lines**

Table (42) show the content of Manganese in various parts of Faba beans, the result show significant increase in roots compared to other parts, where the order was roots>leaves>pods>shoots. There is increase in the roots in all cultivars ,where Baladi recorded the highest value in the roots, accumulation was found in the leaves after roots , in the three cultivars ,the

least value of manganese was found in pods. The result statically show there is no significant different between pods, leaves and shoots.

Table (42) Average content of Manganese in all parts of Faba beans at different lines. Each value is a mean of four replicates .

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	0.04(b)**	0.12(b)**	0.033(b)**
Leaves	0.14(b)**	0.14(b)**	0.13(b)**
Shoots	0.025(b)**	0.022(b)**	0.027(b)**
Roots	0.54(a)**	1.20(a)**	0.57(a)**

****significant between plants part in each cultivars .**

4.4.13 Molybdenum

The result in Table(43) show significant difference between lines in Molybdenum content of whole plants, where it show significant increase in line 1 in Artasi and Baladi ,while it show significant increase in line 2 and 3 in Isbani. No significant difference found between line 1 and 2. Line 3 show significant increase compared to control lines.

Table (43) Average mean content of Molybdenum in all parts of Faba beans at different lines. Each value is a mean of four replicates.

	Cultivars		
Line	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Line 1	0.070(a)*	0.131(a)*	0.0978(ab)*
Line 2	0.047(ab)*	0.070(ab)*	0.1721(a)*
Line 3	0.046(ab)*	0.070(ab)*	0.1721(a)*
Line 5	0.0025(b)*	0.011(b)*	0.0038(b)*

***significant between cultivars at the lines.**

Table (44) show the average mean content of Molybdenum in all parts of Faba beans at different lines ,the result revealed that there is a significant

different between plants parts, there is a significant increase in roots compared to other parts, result show there is no significant different between roots and shoots .Pods recorded the lowest content of Molybdenum,

Table (44) Average mean content of Molbidium in all parts of Faba beans at different lines .each value is a mean of four replicates

	Cultivars		
Plants part	Artasi (ppm)	Baladi (ppm)	Isbani (ppm)
Pods	0.04(b)**	0.12(b)**	0.033(ab)**
Leaves	0.14(b)**	0.14(b)**	0.13(b)**
Shoots	0.025(ab)**	0.022(ab) **	0.027(ab)**
Roots	0.54(a)**	1.20(a)**	0.57(a)**

****significant between plants part in each cultivars**

4.5 Discussion

Salinity and the incorrect use of fertilizers became one of the main problems in Palestine nowadays, especially in dry region of Palestine ,where intensive irrigated agriculture is now being developed, these problems Occupies center stage among the problems that hinder agriculture in our country, which must be studied in order to develop appropriate solutions. The aims of this research to study the changes that occur in the growth in plant has big medical and economic importance in Palestine which is Faba beans.

4.5.1Yeilds

Results shown in table (6) as cooper solution increase the yields of plant increase but not significantly this agree with(Badr and Abou El-Yazied

2007)when they studied tomato they found yields increased when concentration of fertigation increased , this agree with Sainju *et al.,* (2001) when studied Tomato he found a positive increase in yield and quality to increasing N rate. , The result shown in 3times cooper solution there is no yields where the plants died before it reach flowering stage the plants suffering from leaf burning and the leaves became yellow ,where Baladi the first cultivars died ,Isbani the last one dies. This agree with some study on tomato which is highly responsive to N, but application of excessive rates of N is rarely negatively affects quality (Huett and Dettmann, 1988). It shown as salinity increase the yields decrease this result agree with(Khalafallah, et ,al .2008) when studied seven varieties of Faba beans they found a significant decrease in number of pods when salinity increased. where it in 7.8ds/m-^{1} NaCl there is no yields, the plants died in flowering stage, where old leaves burn, and the young leaves turn to yellow color, this agree with(Neumann *et al* ,1988)who concluded that Na+ toxicity symptoms can be recognized as leaf burn, necrotic spots, and this result agree with(Padmore .2009) which excess sodium accumulation in leaves can cause leaf burn, necrotic patches and even defoliation. Plants affected by chloride toxicity exhibit similar foliar symptoms, such as leaf bronzing and necrotic spots in some species. (Tavakkoli et al,2010). Salinity at higher levels causes both hyperionic and hyperosmotic stress and can lead to plant demise.

4.5.2 Growth

4.5.2.1 Vegetative growth

The results in table (7-10) shown the effect of different concentration of Sodium Chloride on the no of leaves, leaves area ,height of shoots, and roots length, where the no of leaves ,leaves area , height of shoots decrease when salinity level increase this result agree with (Azmi and Alam,1990) on Wheat, and so (Cuartero and Munoz,1999) results on Tomato.

The decrease in the growth of three cultivars of Faba beans came from many reasons first, salinity lead to changes in roots growth and physiology which affect absorption of water and nutrients ,and this affect metabolisms in hole plants.(Alhilal ,1420),second, salinity had indirect effects on plants growth ,where photosynthesis products didn't reach to growth regions, and salinity in roots cause decrease in production of hormones which send information to shoots and this decrease growth (Mobaraky.2001) , according to (Alarcon et.al ,1994) salinity strees determined tissue expansion in shoots and leaves cells. Salinity increase Abscisic acid (ABA) which close stomata ,this has appositive affects on tolerant plants leads to Seedlings growth (Shihe,1994) ,and (ABA) has negative effect where its accumulation in cells leads to inhibition of growth . Munns (2002) summarized the sequential events in a plant grown in saline environment. He stated that "In the first few seconds or minutes, water is lost from cells and shrinked. Over hours, cells recover their original volume but the elongation rates are still reduced which led to lower growth rates of leaf and root. Over days, cell division rates are also affected, and contribute to

lower rates of leaf and root growth. Over weeks, changes in vegetative development and over months changes in reproductive development can be seen". According to(Mazher et al., 2007) the changes in enzyme activity , and also the decrease in the level of carbohydrates and growth hormones, both of which can lead to inhibition of the growth. In no of leaves there is no significant different between lines which contain sodium chloride and control line ,studies prove that there is decrease in no of leaves when the concentration of sodium chloride increase , The decrease of leaf numbers may be due to the accumulation of sodium chloride in the cell walls and cytoplasm of the older leaves. At the same time, their vacuole sap cannot accumulate more salt and, thereby decreases the concentration of salt inside the cells, which ultimately leads to their quick death and cut down (Munns, 2002).

Leaf area in table number 8 show significant decrease in leaves area with increase sodium chloride concentration These results agree with what Mathur et al. (2006) reported, that the stress of the moth bean plant (Vigna aconitifolia L.) with increasing concentrations of sodium chloride, led to a decrease in leaf area, This notable decrease in leaf area, found in this study as a result of the treatment with increased concentrations of sodium chloride, could be explained by the negative effect of salt on photosynthesis that leads to the reduction of plant growth, leaf growth, and chlorophyll content (Netondo et al., 2004).

The results in table (7-9) shown that application of three cooper solution on three cultivars of Faba beans affect growth of whole plants ,where no of

leaves, leaves area, and height of shoots increase significantly compared to control plants, except in line 6 where the concentration of cooper solution three times, the plants died after 20 days from planting this happened because of the interaction between nutrients and altering PH which affect the uptake of nutrients , Cooke (1972) reported that the major nutrients required by the crop are Nitrogen (N), Phosphorus (P) and Potassium (K). Inadequate supply of any of these nutrients during crop growth is known to have negative impact on the reproductive capability, growth and yield of the plant.

According to (Lewis, 1992; Britto and Kronzucker, 2002) Ammonium build-up can consequently have toxic effects, including decrease uptake of important cationic nutrients, such as K^{+}, Ca^{2+} and Mg^{2+}. Excess P indirectly affects plant growth by reducing Fe, Mn and Zn uptake; thus potentially causing deficiency symptoms of these nutrients to occur, while K toxicity can cause reduced uptake and subsequent deficiencies of Mg, and in some cases, Ca (McCauley et al ,2011), excess N results in tall plants with weak stems, possibly causing lodging. New growth will be succulent and plant transpiration high (Jacobsen and Jasper, 1991). Other micronutrients causing potential toxicity symptoms include Cu, Mn, Mo, Ni and Zn ,according to (Mengel and Kirkby, 2001) excess Cu will decrease Fe and other metal in planting area ,that causing chlorosis and other Fe deficiency symptoms, such as stunted growth. In line 1(1 cooper solution) and line 2(25% cooper solution) the result show there is no significant different between them in vegetative growth, this may happened because of the

competition between ions ,when the concentration of ions increase the competition increase, according to ,(Marschner,2012) competition occurs particularly between ions with similar chemical properties (valency), example of type of anion competition occurs between Chloride and Nitrate ,Chloride concentrations in plant tissues ,particularly in roots , can be reduced strongly by increasing nitrate availability (White and Broadley ,2001),this may lead to many ions inhibiting from entering to roots and many ions absorbed than other ions ,this will appear deficiency and toxicity symptoms on plants. and another reasons may be due to osmotic pressure, an indirect way to estimate the osmotic pressure of the nutrient solution is the electrical conductivity (EC) which is an index of salt concentration that defines the total amount of salts in a solution. Higher EC hinders nutrient uptake by increasing osmotic pressure, whereas lower EC may severely affect plant health and yield (Samarakoon et al, 2006).

In line 1,2 there is a significant increase in vegetative growth compared to control line, Cooper solution contain macronutrients like N,K,P which play central role in vegetative growth, N absorbed by plant in different form like: NO_2,NO_3,NH_4, $(NH_4)_2HPO_4$..etc, nitrate increased total Chlorophyll content Wellburn et at. (1972) observed disruptions in the ultra structure of chloroplasts from Vicia faba leaves exposed to 3 ppm NO_2, Effects of NO_2 on growth, pigment, and nitrogenous contents and related enzyme activities are strongly influenced by nutrient N level. (Hari and Douglas,1984), Nitrogen is needed for vigorous vegetative leaf and stem growth and dark green leaf color (chlorophyll production). It is part of proteins, enzymes,

chlorophyll, and growth regulators. So that it enhance leaves no, leaves area ,height of shoots, and yields.

Plants most often absorb phosphorus in the form of phosphate ions H_2PO_4 and sometimes as HPO_4 (Feller, 1995) indicated that P and fertilizers significantly increased leaf number, leaf area, branching and shoot length this is because Phosphorus has many important functions in plants, the primary one being the storage and transfer of energy through the plant Adenosine di phosphate (ADP) and adenosine tri phosphate (ATP) are high-energy phosphate compounds that control most processes in plants including photosynthesis, respiration, protein and nucleic acid synthesis, and nutrient transport through the plant's cells(Mullins,2009). K^+ is essential to all plant life, The cellular roles that K^+ plays have been frequently reviewed by (e.g. Kochian and Lucas, 1988; Maathuis and Sanders, 1996) and can be summarized as: (1) charge balancing in the cytoplasm, where K^+ is the dominant counter ion for the large excess of negative charge on proteins and nucleic acids; (2) activation of crucial enzymatic reactions such as occurring in the formation of pyruvate; and (3) a substantial contribution to the osmotic pressure of the vacuole and hence to cell turgor which endows non-lignified plant cells with structural rigidity. For these reasons k works to increase crop yields and vegetative growth.

4.5.3 Fresh and dry weight

Tables (11-18) explained the effect of two concentration of cooper solution and one concentration of sodium chloride on fresh and dry weight of roots,

shoots, leaves, and pods, where results shown increase in fresh and dry weight of whole plants when treated with 4.68ds/m-^{1},NaCl compared to controls plants, but the increase not significant, many Salinity has been reported to reduce shoot and root weights in legumes, e.g. chickpea (Lauter and Munns, 1987), , and faba bean (Vicia faba) (Yousef and Sprent, 1983; Zahran and Sprent, 1986), and this agree with Bayuelo Jimenez et al., (2002); Jamil et al., (2005); Niaz et al., (2005); Saqib et al., (2006); They have shown that the fresh and dry weights of the shoot system are affected, either negatively or positively, by changes in salinity concentration, type of salt present, or type of plant species. In spite of the fact that many studies have pointed to the negative effect of sodium chloride on fresh and dry weight, there are contrary results, as well, pointing to the positive effect of salt stress on fresh and dry weight.these include Andriolo et al. (2005) in their study on lettuce (Lactuca sativa L.), Dantus et al. (2005) on cowpea (Vigna unguiculata L.), and Niaz et al. (2005), On fodder beet (Beta vulgaris L.) and sea beet (Beta maritime L.) where they report an increase in the fresh and dry weight for root and shoot systems of the plants with concentrations of NaCl. The increase in fresh weight of the shoot system may be due to the ability of the plant to increase the size of its sap vacuoles, which allows for the collection of a lot of water, and this in turn dissolves salt ions that have accumulated and leads to the subsequent increase in fresh weight (Munns, 2002).

In case of application copper solution on the cultivars of Faba beans and its effect on the fresh and dry weight of plants , the result in tables (13.14.15.

and 16) show significant different in line 1and 2 in all cultivars, compared to control line, Statically there is no significant different between line 1 and 2 in fresh and dry weight of whole plants. However, there is increase in fresh and dry weight in line 1 compared to line 2. There are many reasons for why line1(1 copper) no significant with line2(25% copper) , fresh weight and dry weight of vegetative growth depends on nutrients uptake ,so that any effect in nutrients uptake will effect the growth, in line (1) the percentage of nutrients more than line (2) this make competition between ions increase and so the nutrients uptake affect by permitting some ion uptake and inhibit others. This agree with many study focused on this issue Many studies mentioned that there is a relationship between ions , ions can effect on other ions. According to(Lewis, 1992; Britto and Kronzucker, 2002) Ammonium build-up can consequently have toxic effects, including the suppressed uptake of important cationic nutrients, such as K^+ , Ca^{2+} and Mg^{2+} . Excess P indirectly affects plant growth by reducing Fe, Mn and Zn uptake; thus potentially causing deficiency symptoms of these nutrients to occur, K toxicity can cause reduced uptake and subsequent deficiencies of Mg, and in some cases, Ca(McCauley et al ,2011).

4.5. 4 Nutrients Distribution

This study revealed a significant difference between three cultivars of broad bean grown in one levels alt concentration and two levels of cooper solution table (19-44) show the significant and non significant value according to lines or to plant parts . According to Abdel- Wahab and Zahran (1981) and Cordovilla *et al*. (1995) *Vicia faba* L., *Phaseolus*

vulgaris L., and (*Glycine max*(L.) Merr.) are more salt tolerant plants than other legumes. The adjustment to the salinity may have allowed synthesis of highly water-soluble compatible osmotica such as glycinebetaine, free proline, and low molecular weight sugars to maintain turgor (wahid 2004). The acceptance of broad bean as a salt-tolerant plant might be related to the compartmentation mechanisms achieved by plant protoplasm to cope with higher salt concentration(koyro,1997)

Nitrate in plant parts:

It was noted that the concentration of nitrate increased in line1 and 2and 3 compared to line 5,where the order was line1>line2>line3>line5. low nitrate concentration led to decrease the concentration of the nutrient nitrogen in plants , and this is evident in the decline of Line 2 than Line1, there is increase in Nitrate in line (3) compared to control but not significant, according to (El Sayed.2011) Total free amino acid, especially proline, tended to increase with salinity concentration which rise nitrogen content . The result revealed that Nitrate increase in the leaves and roots in but decrease in shoots and pods.this agree with (Cordovilla, et al 1995)In the salinity in legumes effect on nitrogen fixation and biomass reduction might be directly related to the salt induced decline in dry weight and nitrogen content in the shoot .

Sulfate in plant parts:

It was noted that increase copper solution, increase Sulphate content where it line1>line2>line3>line5, where there is no significant different between

line(1)and line(2) which may be due to the competition in line 1 between nutrients more than line 2,which may inhibit extreme absorption of nutrients. result show increase in line 3 compared to control line(5),but this increase not significant. this agree with(Mansour.et al 2005)reported that increase salinity will increase SO_4^- in plant parts. the result revealed that in the root concentration of Sulphate recorded the highest concentration ,then the concentration decrease in the shoots, leaves ,pods In descending .

Phosphate in plant parts:

It was found that the concentration of phosphorus increased when increased cooper solution, where line1>line2>line3>line5,its was found that there is no significant different between line1 and 2, which may be due to the competition in line 1 between nutrients more than line 2,which may inhibit extreme absorption of nutrients. in line 3 there is increase compared to control line which lead to that salinity increase content of phosphate ,this recorded by (Strogonov,1964) and reported by (Ravikovitch.1970) whereas increased P_3^+ content due to salt stress. It was noted that that phosphate found to increase in the roots and the pods of the three cultivars, while it decrease in shoots and leaves.

Potassium in plant parts:

It was noted from the result that increase in cooper solution increased K content where it line1>line2>line5>line3.while there is no significant different between line 1and 2. In line 3 the result show decrease in Potassium concentration compared to control line, but this decrease

statically not significant, according to(El Sayed.2011) The decrease in K^+ content in various parts of the bean plant in response to salinization reflects the salt sensitive nature of this species. the reason why K reduced in Salinity is may be to K^+ uptake is competitively reduced due to Na+, According to Benzyl and Reuveni(1994) and Qian *et al.*(2001), the tolerance of *Vicia* sp. to salinity may be more related to the K^+ /Na^+ ratio in the cell than the absolute Na^+ concentration.

Sodium

It was found that result show significant increase in line (3) , compared to others lines, where line3>line5>line2>line1, Result show significant decrease in line (1) and (2) when compared to line (3) the reason of the decrease in sodium content is due to the competition of Na^+ with K^+ and others ions, according to(Marschner,2012) competition occurs particularly between ions with similar physicochemical properties (valency and ion diameter),in line 3 the percentage of K is too little , which permit maximum uptake of Sodium. It was found that Sodium accumulate in plant tissue in this order .roots >shoots>leaves>pods.

Magnesium in plant parts:

Its noted from the result that there is no significant difference between lines, and it show statically there is no significant difference between cultivars in the lines. Although there is slightly increase in line 1 and 2 ,compared to the control line ,because Cooper solution contain Mg ,but why the increase not significant , its may be due to the competition of Mg

with other ions, or it may be due to precipitation of Mg in the bottom of tank. In line 3 there is slightly decrease in Mg compared to control line. this may be due to competition with Na. According to (Marschner, 1995) magnesium ions are cofactors required for the activity of different enzymes, including enzymes involved in respiration and photosynthesis, or in the synthesis of DNA and RNA; Mg also forms part of the ring structure of the chlorophyll molecule. Apart from these general functions of magnesium, very little is known regarding its (possible) specific roles on the mechanisms of response of plants to high soil salinity and salt tolerance. Because part of the experiment in winter ,the temperature play role in uptake of Mg .In the high or in the low temperature, the nutrients distribution in plant will be affected because of the uptake of one ion on account other ions ,for example , compared with Ca^{2+} and Mg^{2+} ,uptake rates of $K^{+}$are often more effected by root zone temperature .In winter wheat , the increase in $K^{+}/(Ca^{2+}Mg^{2+})$ ratios in the shoots with increasing root zone temperature may cause tetany in grazing beef cattle on winter wheat forage (Miyasaka and Grunes,1990) .

Chloride in plant parts:

it was found from the result that there is a significant increase in line 3 compared to other lines, where it was in this order line3>line5>line2>line1. We see that when cooper solution increased chloride content decreased, this happened because of Nitrate where it compete with chloride and this agree with(White and Broadley ,2001),that reported anion competition occurs between Chloride and Nitrate ,Chloride concentrations in plant

tissues ,particularly in roots , can be reduced strongly by increasing nitrate availability , and these result agree with(Bernal et al 1975) reported that It was proposed that the high uptake of Cl^- relative to Na^+ in salt stressed plants could be responsible for growth inhibition by depressing uptake of other anions such as nitrates. and so what prove the hypothesis of competition is line (3) where the content of chloride increase because the the little percent of Nitrate.

Copper in plant parts:

It was found from the results that no significant different between lines, but there is slightly increase in line 1 and 2 compared to control , because cooper solution contain copper in different concentrations, In line 3 there is slightly increase compare to the control line in the three cultivars ,it was noted that copper accumulate in roots and leaves. Cu play important role in many enzyme in plants ,so that its increase in line 3 may be to cope with salinity stress .

Calcium in plant parts:

It was noted that from the result there is no significant different between lines. However, in line 1and 2 show decrease ,when compared to control line , this may be due to quality of nutrients in the nutrient solution hinder and compete in the absorption of calcium, so calcium percentage found in Line 2 is greater than Line 1. Line 3 show increase of calcium content compared to line1 and 2,which is evidence that salinity increase calcium content in plants,this agree with(Epstein.1969) that reported Ca^{2+} play a

major role in salt tolerance, according to(Marschner,1978) most worker have observed a depressive effect of Na^{+} on Ca^{2+} uptake. According to Xiong and Zhu (2002)calcium is an important determinant for homeostasis particularly relevant to sodium and potassium for plants salt tolerance. It also plays major role both in solution culture and in soils after its increased calcium supply has a protective effect on plants exposed to sodium. It is also plays major role both in solution culture and in soils after its increased calcium supply has a protective effect on plants exposed to sodium.

Iron in plant parts:

Its noted from the result that there is no significant different between lines, although there is increase in line 1in all cultivars compared to other lines, but this increase not significant. in line 2 show decrease in Fe content this is may be due to the decrease in the dose that plants had been taken. Generally the content of Fe do not show significant difference in line(1)and (2) compared to control line, this may be due to deposit of Fe in the tank ,where a part of b Fe-Edeta didn't dissolved in water and accumulate in the bottom of tank . To keep Fe available and prevent deficiency, Fe is often added to nutrient solutions in chelated form .Many researchers have shown that chelates reduce the plant uptake of metals in nutrient solutions (Bachman and Miller, 1995). In line 3 there is slightly increase in the content of iron in whole plant. Similarly increased levels of Fe^{3+} resulting from salinity treatments have been reported for tomato, squash, soybean,

(Maas et al .1972), this may be due to Interactions between Fe and P fall in the first category, whereas interactions between (Fe and Zn, Mn and Cu).

Zinc in plant parts:

Its was noted from the result there is a significant different between lines in the content of zinc, where line 1 recorded the highest content of zinc in the three cultivars ,this increase because cooper solution contain Zinc, so that plants absorbed zinc dependent on its concentration in the solutions. In line 3 there is increased in Zn content in two cultivars, compared to line 5. Zinc play important role in activates enzyme(Stevens et al ,2002), so that its increase in salinity may be to cope with salinity stress.

Manganese in plant parts:

Its was noted from the result there significant increase in line(1)compared to others lines, where the concentration of Manganese was(line1> line2> line3 >line5).the increase in line1 and 2 is due to its concentration in cooper solution ,where it line 1 larger than line 2. Salinity in line 3 increased Mn this agree with (Maas et al .1972) Mn^{2+} content increased in the shoots of tomato and soybean but decreased in tops of squash due to NaCl .this increase may be came from the role that Mn play in the plants where it apart of activate enzyme so it increase to cope with salinity stress

Molybdenum in plant parts:

It was found from the results that there is a significant difference between lines in Molybdenum content of whole plants, where it show significant increase in line 1 ,and 2 because its concentration in cooper solution

,asignificant increase found in line 3 compared to control .Mo play important role in nitrogen fixation(Stevens et al ,2002), only extremely small amounts of Mo are required for normal plant growth, reduced supply with Mo to the growth medium decreased activities of the enzymes, to cope with salinity stress plant must increased Mo.

The results that have been reached were not far from the results of previous studies in general, but there is a slight discrepancy in terms of the values that were measured and it was due to weather conditions surrounding plants .The experiment was obstruction and response some of the problems, and the most important problems that have affected plant life and came close to destroying the experiment, the case weather, such as wind speed wich affect plants flower ,and the other problem is the birds that had been attacking pods, because the roots of the plants remain continuously in the nutrient solution, which allows deposition of salts on the roots of plants.

Conclusion

The objective of this study is to identify the effect of salinity and nutrients on three cultivars of Faba beans plants in piped hydroponics in the natural conditions of climate without any modification, and this study is important in terms of social and research, because it shows the extent of carrying Faba beans plant to stress caused by salinity and plant nutrients necessary within the different levels of salinity, The outcome of this experiment are as follows:

- The effect of nutrients on Faba beans has been positive, but the study show, there is no significant difference between 1 cooper and 25%

cooper in growth and yield, where increased nutrient value that needs the plant does not lead to growth, yield and production more than usual, but may adversely affect the plants, this like what happened in three times cooper solution where the plants died in the early stages .

- Growth, performance of Faba beans have been negatively affected by 4.68ds/m-^{1} NaCl , while plants at 7.8 ds/m-^{1} NaCl had been dying at flowering stage, Faba beans is a moderate salt tolerant plants which may grow and produce under salt stress, but it prefers to add nutrients.
- In terms of nutrition, depending on the results influenced by the concentration of elements and nutrients in parts of Faba beans on the concentration of nutrients in the nutrient solution, so it can take advantage of this effect in the increase or decrease of certain nutrients such as reducing nutrients in the nutrient solution leads to increased other nutrients.
- Faba beans classified as salt moderate tolerant plants ,It was show from the result that cultivars Isbani and Baladi more tolerant to salinity than Artasi.
- Production of the three cultivars of Faba beans are similar to that in the soil ,but plants height is shorter than that in soil, planting Fava beans in hydroponics is economically inefficient. because it needs more care and many instruments and chemicals. but it's good for whom haven’t space to grow in it.

- Salinity affect nutrients distribution in Faba beans ,where some nutrients increase in plant parts as Na ,Ca , Cl, while other nutrients decrease as K and NO_3.

These results, which got similar to many previous studies, but there are differences in terms of chemical analysis of nutrients, as the values of concentrations or physical measurements differed from the results of previous studies, and the reason for that is the circumstances surrounding the experiment and the system that was used in the cultivation of plants, and type of nutrients solution , salinity levels ,planting date, cultivation duration and growth place differed from previous studies.

Recommendations to the Palestinian community in general, civil society and the private,:-

- Hydroponics systems are a new method used for agriculture in many areas in the world ,so its need to application this system on a large scale , because the system does not need a big space so that it can exploit the rooftops of agricultural production, the system does not require a large quantity of fertilizer that lead to financial and environmental loss, as well as the exploitation with low quality water, and the high productions especially in vegetables .

The recommendations for researchers:

- Cultivation of Faba beans plants in the system (PHS), because according to the expected growth of the plants will be better because of preventing the deposition of salts on the roots that lead to block the

absorption of water and salts necessary for plants, in addition to aeration roots.

- Study the effect of salinity on Faba beans plants in hydroponics at different levels of salinity between the extent (2 - 8) ds/m-^{1}, in order to determine the maximum tolerable in beans without affecting the growth and performance of the plant.
- Study the effect of a few types (pairs) of nutrients within different levels of salinity, due to the existence of relationships and complex interactions occur between the ions in nutrient solutions and within the plant tissue.

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Appendix

Statical analysis was conducted using one way ANOVA test, test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines ,table 1-3 in appendix show ANOVA test for Baladi, Artasi and Isbani cultivars according to lines the output have a statistically significant difference between group means

Table 1: ANOVA analysis of vegetative growth for Baladi cultivars according to lines.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
no of pods	Between Groups	411.333	5	82.267	8.414	.000
	Within Groups	176.000	18	9.778		
	Total	587.333	23			
no of leaves	Between Groups	66375.500	5	13275.100	57.823	.000
	Within Groups	4132.500	18	229.583		
	Total	70508.000	23			
leaves area	Between Groups	2937302.500	5	587460.500	151.952	.000
	Within Groups	69589.500	18	3866.083		
	Total	3006892.000	23			
height of shoot	Between Groups	2889.875	5	577.975	69.473	.000
	Within Groups	149.750	18	8.319		
	Total	3039.625	23			
root length	Between Groups	1499.833	5	299.967	142.089	.000
	Within Groups	38.000	18	2.111		
	Total	1537.833	23			

Table 2 ANOVA analysis of vegetative growth for Artasi according to lines

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
no of pods	Between Groups	250.708	5	50.142	16.045	.000
	Within Groups	56.250	18	3.125		
	Total	306.958	23			
no of leaves	Between Groups	55712.708	5	11142.542	9.229	.000
	Within Groups	21733.250	18	1207.403		
	Total	77445.958	23			
leaves area	Between Groups	3363590.833	5	672718.167	13.595	.000
	Within Groups	890670.500	18	49481.694		
	Total	4254261.333	23			
height of shoot	Between Groups	2643.708	5	528.742	28.906	.000
	Within Groups	329.250	18	18.292		
	Total	2972.958	23			
root length	Between Groups	1956.875	5	391.375	144.508	.000
	Within Groups	48.750	18	2.708		
	Total	2005.625	23			

Table 3 ANOVA analysis of vegetative growth for Isbani according to lines

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
no of pods	Between Groups	322.333	5	64.467	20.181	.000
	Within Groups	57.500	18	3.194		
	Total	379.833	23			
no of leaves	Between Groups	66533.875	5	13306.775	37.532	.000
	Within Groups	6381.750	18	354.542		
	Total	72915.625	23			
leaves area	Between Groups	2682916.375	5	536583.275	72.933	.000
	Within Groups	132429.250	18	7357.181		
	Total	2815345.625	23			
height of shoot	Between Groups	2236.333	5	447.267	39.272	.000
	Within Groups	205.000	18	11.389		
	Total	2441.333	23			
root length	Between Groups	3146.000	5	629.200	165.337	.000
	Within Groups	68.500	18	3.806		
	Total	3214.500	23			

Table 4 . ANOVA analysis of vegetative growth line 1 according to cultivars.

	Sumof Squares	df	Mean Square	F	Sig.
number of pods (Combined)	8.667	2	4.333	.211	.814
Linear Term Contrast	.500	1	.500	.024	.880
Between Groups	8.167	1	8.167	.397	.544
Within Groups	185.000	9	20.556		
Total	193.667	11			
(Combined) number of leaves	113.167	2	56.583	.019	.982
Linear Term Contrast	21.125	1	21.125	.007	.935
Between Groups	92.042	1	92.042	.030	.866
Within Groups	27333.750	9	3037.083		
Total	27446.917	11			
(Combined) leaves area	39051.167	2	19525.583	.216	.810
Linear Term Contrast	37401.125	1	37401.125	.413	.536
Between Groups	1650.042	1	1650.042	.018	.896
Within Groups	815104.500	9	90567.167		
Total	854155.667	11			
(Combined) height of shoot	32.667	2	16.333	.561	.590
Linear Term Contrast	12.500	1	12.500	.429	.529
Between Groups	20.167	1	20.167	.692	.427
Within Groups	262.250	9	29.139		
Total	294.917	11			
(Combined) root length	12.500	2	6.250	1.585	.257
Linear Term Contrast	12.500	1	12.500	3.169	.109
Between Groups	.000	1	.000	.000	1.000
Within Groups	35.500	9	3.944		
Total	48.000	11			

Table 5 . ANOVA analysis of vegetative growth line 2 according to cultivars.

ANOVA

		Sumof Squares	df	Mean Square	F	Sig.
number of pods	(Combined)	18.500	2	9.250	.845	.461
	Linear Term Contrast	12.500	1	12.500	1.142	.313
	Between Groups	6.000	1	6.000	.548	.478
	Within Groups	98.500	9	10.944		
	Total	117.000	11			
number of leaves	(Combined)	3421.500	2	1710.750	15.540	.001
	Linear Term Contrast	3403.125	1	3403.125	30.914	.000
	Between Groups	18.375	1	18.375	.167	.692
	Within Groups	990.750	9	110.083		
	Total	4412.250	11			
area	(Combined) leaves	55572.667	2	27786.333	1.430	.289
	Linear Term Contrast	52164.500	1	52164.500	2.685	.136
	Between Groups	3408.167	1	3408.167	.175	.685
	Within Groups	174850.000	9	19427.778		
	Total	230422.667	11			
of shoot	(Combined) height	.500	2	.250	.022	.978
	Linear Term Contrast	.125	1	.125	.011	.919
	Between Groups	.375	1	.375	.033	.860
	Within Groups	102.500	9	11.389		
	Total	103.000	11			
root length	(Combined)	51.500	2	25.750	8.664	.008
	Linear Term Contrast	50.000	1	50.000	16.822	.003
	Between Groups	1.500	1	1.500	.505	.495
	Within Groups	26.750	9	2.972		
	Total	78.250	11			

Table 6 ANOVA analysis of vegetative growth line3 according to cultivars

	Sumof Squares	df	Mean Square	F	Sig.
number of pods (Combined)	.167	2	.083	.300	.748
Linear Term Contrast	.000	1	.000	.000	1.00
Between Groups	.167	1	.167	.600	.458
Within Groups	2.500	9	.278		
Total	2.667	11			
number of leaves (Combined)	98.167	2	49.083	.751	.499
Linear Term Contrast	21.125	1	21.125	.323	.584
Between Groups	77.042	1	77.042	1.178	.306
Within Groups	588.500	9	65.389		
Total	686.667	11			
leaves area (Combined)	8129.167	2	4064.583	2.189	.168
Linear Term Contrast	8128.125	1	8128.125	4.378	.066
Between Groups	1.042	1	1.042	.001	.982
Within Groups	16708.500	9	1856.500		
Total	24837.667	11			
height of shoot (Combined)	2.167	2	1.083	.073	.930
Linear Term Contrast	.125	1	.125	.008	.929
Between Groups	2.042	1	2.042	.138	.719
Within Groups	133.500	9	14.833		
Total	135.667	11			
root length (Combined)	692.167	2	346.083	95.838	0.00
Linear Term Contrast	72.000	1	72.000	19.938	.002
Between Groups	620.167	1	620.167	171.738	0.00
Within Groups	32.500	9	3.611		
Total	724.667	11			

Table 7: ANOVA analysis of vegetative growth line 4 according to cultivars

	Sumof Squares	df	Mean Square	F	Sig.
number of pods (Combined)	.000	2	.000	.	.
Linear Term Contrast	.000	1	.000	.	
Between Groups	.000	1	.000	.	
Within Groups	.000	9	.000		
Total	.000	11			
number of leaves (Combined)	31.500	2	15.750	.524	.609
Linear Term Contrast	28.125	1	28.125	.936	.359
Between Groups	3.375	1	3.375	.112	.745
Within Groups	270.500	9	30.056		
Total	302.000	11			
leaves area (Combined)	832.167	2	416.083	1.678	.240
Linear Term Contrast	128.000	1	128.000	.516	.491
Between Groups	704.167	1	704.167	2.840	.126
Within Groups	2231.500	9	247.944		
Total	3063.667	11			
height of shoot (Combined)	17.167	2	8.583	.863	.454
Linear Term Contrast	10.125	1	10.125	1.018	.339
Between Groups	7.042	1	7.042	.708	.422
Within Groups	89.500	9	9.944		
Total	106.667	11			
root length (Combined)	50.167	2	25.083	9.214	.007
Linear Term Contrast	28.125	1	28.125	10.332	.011
Between Groups	22.042	1	22.042	8.097	.019
Within Groups	24.500	9	2.722		
Total	74.667	11			

Table 8 ANOVA analysis of vegetative growth line 5 according to cultivars

	Sumof Squares	df	Mean Square	F	Sig.
number of pods (Combined)	3.167	2	1.583	3.800	.064
Linear Term Contrast	3.125	1	3.125	7.500	.023
Between Groups	.042	1	.042	.100	.759
Within Groups	3.750	9	.417		
Total	6.917	11			
number of leaves (Combined)	4132.667	2	2066.333	6.205	.020
Linear Term Contrast	3362.000	1	3362.000	10.096	.011
Between Groups	770.667	1	770.667	2.314	.163
Within Groups	2997.000	9	333.000		
Total	7129.667	11			
leaves area (Combined)	101654.167	2	50827.083	5.477	.028
Linear Term Contrast	55278.125	1	55278.125	5.956	.037
Between Groups	46376.042	1	46376.042	4.997	.052
Within Groups	83526.750	9	9280.750		
Total	185180.917	11			
height of shoot (Combined)	32.000	2	16.000	1.846	.213
Linear Term Contrast	8.000	1	8.000	.923	.362
Between Groups	24.000	1	24.000	2.769	.130
Within Groups	78.000	9	8.667		
Total	110.000	11			
root length (Combined)	173.167	2	86.583	53.741	.000
Linear Term Contrast	171.125	1	171.125	106.216	.000
Between Groups	2.042	1	2.042	1.267	.289
Within Groups	14.500	9	1.611		
Total	187.667	11			

Table 9 ANOVA analysis of vegetative growth line 6 according to cultivars

	Sumof Squares	df	Mean Square	F	Sig.
number of pods (Combined)	.000	2	.000	.	.
Linear Term Contrast	.000	1	.000	.	
Between Groups	.000	1	.000	.	
Within Groups	.000	9	.000		
Total	.000	11			
number of leaves (Combined)	14.000	2	7.000	.940	.426
Linear Term Contrast	8.000	1	8.000	1.075	.327
Between Groups	6.000	1	6.000	.806	.393
Within Groups	67.000	9	7.444		
Total	81.000	11			
leaves area (Combined)	56.000	2	28.000	.940	.426
Linear Term Contrast	32.000	1	32.000	1.075	.327
Between Groups	24.000	1	24.000	.806	.393
Within Groups	268.000	9	29.778		
Total	324.000	11			
height of shoot (Combined)	26.000	2	13.000	6.411	.019
Linear Term Contrast	12.500	1	12.500	6.164	.035
Between Groups	13.500	1	13.500	6.658	.030
Within Groups	18.250	9	2.028		
Total	44.250	11			
root length (Combined)	12.167	2	6.083	2.547	.133
Linear Term Contrast	.125	1	.125	.052	.824
Between Groups	12.042	1	12.042	5.041	.051
Within Groups	21.500	9	2.389		
Total	33.667	11			

2- Fresh and dry weight

Statical analysis was conducted using one way ANOVA test, test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines ,table 10-12 in appendix show ANOVA test for, Artasi , Isbani and Baladi cultivars according to lines the output have a statistically significant difference between group means. It was see that the significance level is ($p < 0.05$),

Table (10) ANOVA analysis of fresh and dry weight of Artasi

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	7554.596	3	2518.199	6.815	.006
	Within Groups	4434.409	12	369.534		
	Total	11989.005	15			
Dry weight of roots	Between Groups	133.459	3	44.486	15.086	.000
	Within Groups	35.386	12	2.949		
	Total	168.845	15			
Fresh weight of stems	Between Groups	12273.933	3	4091.311	12.936	.000
	Within Groups	3795.266	12	316.272		
	Total	16069.199	15			
Dry weight of stems	Between Groups	988.827	3	329.609	10.153	.001
	Within Groups	389.583	12	32.465		
	Total	1378.410	15			
Fresh weight of leaves	Between Groups	13376.779	3	4458.926	17.210	.000
	Within Groups	3109.030	12	259.086		
	Total	16485.809	15			
Dry weight of leaves	Between Groups	600.672	3	200.224	24.068	.000
	Within Groups	99.828	12	8.319		
	Total	700.500	15			
Fresh weight of pods	Between Groups	9905.323	3	3301.774	10.436	.001
	Within Groups	3796.634	12	316.386		
	Total	13701.957	15			
Dry weight of pods	Between Groups	246.620	3	82.207	15.815	.000
	Within Groups	62.376	12	5.198		
	Total	308.996	15			

Table 11) ANOVA analysis of fresh and dry weight of Isbani

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	9825.208	3	3275.069	8.016	.003
	Within Groups	4903.091	12	408.591		
	Total	14728.299	15			
Dry weight of roots	Between Groups	181.888	3	60.629	13.987	.000
	Within Groups	52.017	12	4.335		
	Total	233.906	15			
Fresh weight of stems	Between Groups	10918.865	3	3639.622	14.972	.000
	Within Groups	2917.195	12	243.100		
	Total	13836.060	15			
Dry weight of stems	Between Groups	782.147	3	260.716	16.005	.000
	Within Groups	195.476	12	16.290		
	Total	977.623	15			
Fresh weight of leaves	Between Groups	4815.888	3	1605.296	18.038	.000
	Within Groups	1067.914	12	88.993		
	Total	5883.802	15			
Dry weight of leaves	Between Groups	299.280	3	99.760	17.106	.000
	Within Groups	69.983	12	5.832		
	Total	369.262	15			
Fresh weight of pods	Between Groups	10035.506	3	3345.169	20.254	.000
	Within Groups	1981.883	12	165.157		
	Total	12017.389	15			
Dry weight of pods	Between Groups	275.038	3	91.679	19.524	.000
	Within Groups	56.349	12	4.696		
	Total	331.387	15			

Table 12) ANOVA analysis of fresh and dry weight of Baladi

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	3756.749	3	1252.250	21.894	.000
	Within Groups	686.342	12	57.195		
	Total	4443.091	15			
Dry weight of roots	Between Groups	123.498	3	41.166	14.422	.000
	Within Groups	34.253	12	2.854		
	Total	157.751	15			
Fresh weight of stems	Between Groups	10070.544	3	3356.848	29.687	.000
	Within Groups	1356.905	12	113.075		
	Total	11427.449	15			
Dry weight of stems	Between Groups	776.562	3	258.854	23.982	.000
	Within Groups	129.521	12	10.793		
	Total	906.083	15			
Fresh weight of leaves	Between Groups	4577.781	3	1525.927	24.816	.000
	Within Groups	737.889	12	61.491		
	Total	5315.670	15			
Dry weight of leaves	Between Groups	305.456	3	101.819	15.361	.000
	Within Groups	79.543	12	6.629		
	Total	385.000	15			
Fresh weight of pods	Between Groups	6263.484	3	2087.828	8.103	.003
	Within Groups	3091.942	12	257.662		
	Total	9355.426	15			
Dry weight of pods	Between Groups	247.307	3	82.436	4.899	.019
	Within Groups	201.904	12	16.825		
	Total	449.211	15			

Table 13) ANOVA analysis of fresh and dry weight in line 1

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	1295.997	2	647.999	3.070	.096
	Within Groups	1899.977	9	211.109		
	Total	3195.974	11			
Dry weight of roots	Between Groups	8.308	2	4.154	4.255	.050
	Within Groups	8.787	9	.976		
	Total	17.095	11			
Fresh weight of stems	Between Groups	509.436	2	254.718	1.397	.296
	Within Groups	1641.386	9	182.376		
	Total	2150.822	11			
Dry weight of stems	Between Groups	24.345	2	12.173	.638	.551
	Within Groups	171.841	9	19.093		
	Total	196.186	11			
Fresh weight of leaves	Between Groups	1249.201	2	624.600	4.211	.051
	Within Groups	1334.932	9	148.326		
	Total	2584.133	11			
Dry weight of leaves	Between Groups	37.297	2	18.648	3.184	.090
	Within Groups	52.705	9	5.856		
	Total	90.002	11			
Fresh weight of pods	Between Groups	810.693	2	405.346	1.121	.368
	Within Groups	3255.214	9	361.690		
	Total	4065.907	11			
Dry weight of pods	Between Groups	14.571	2	7.286	.996	.407
	Within Groups	65.856	9	7.317		
	Total	80.427	11			

Table 14) ANOVA analysis of fresh and dry weight in line 2

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	1886.460	2	943.230	1.063	.385
	Within Groups	7983.742	9	887.082		
	Total	9870.202	11			
Dry weight of roots	Between Groups	5.601	2	2.801	.226	.802
	Within Groups	111.402	9	12.378		
	Total	117.003	11			
Fresh weight of stems	Between Groups	26.341	2	13.170	.019	.982
	Within Groups	6374.273	9	708.253		
	Total	6400.614	11			
Dry weight of stems	Between Groups	10.042	2	5.021	.084	.920
	Within Groups	539.740	9	59.971		
	Total	549.781	11			
Fresh weight of leaves	Between Groups	2102.613	2	1051.306	2.658	.124
	Within Groups	3559.951	9	395.550		
	Total	5662.563	11			
Dry weight of leaves	Between Groups	46.152	2	23.076	1.060	.386
	Within Groups	195.849	9	21.761		
	Total	242.000	11			
Fresh weight of pods	Between Groups	31.569	2	15.785	.025	.975
	Within Groups	5611.555	9	623.506		
	Total	5643.124	11			
Dry weight of pods	Between Groups	8.310	2	4.155	.147	.865
	Within Groups	254.677	9	28.297		
	Total	262.987	11			

Table 15) ANOVA analysis of fresh and dry weight in line 3

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	53.913	2	26.957	3.776	.064
	Within Groups	64.255	9	7.139		
	Total	118.169	11			
Dry weight of roots	Between Groups	.264	2	.132	2.529	.134
	Within Groups	.469	9	.052		
	Total	.733	11			
Fresh weight of stems	Between Groups	19.221	2	9.610	2.250	.161
	Within Groups	38.443	9	4.271		
	Total	57.664	11			
Dry weight of stems	Between Groups	1.258	2	.629	2.474	.139
	Within Groups	2.289	9	.254		
	Total	3.548	11			
Fresh weight of leaves	Between Groups	15.243	2	7.622	22.181	.000
	Within Groups	3.093	9	.344		
	Total	18.336	11			
Dry weight of leaves	Between Groups	.295	2	.148	97.622	.000
	Within Groups	.014	9	.002		
	Total	.309	11			
Fresh weight of pods	Between Groups	1.533	2	.766	4.408	.046
	Within Groups	1.565	9	.174		
	Total	3.098	11			
Dry weight of pods	Between Groups	.093	2	.046	5.324	.030
	Within Groups	.078	9	.009		
	Total	.171	11			

Table 16) ANOVA analysis of fresh and dry weight in line 5

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Fresh weight of roots	Between Groups	125.458	2	62.729	7.441	.012
	Within Groups	75.868	9	8.430		
	Total	201.325	11			
Dry weight of roots	Between Groups	2.087	2	1.043	9.405	.006
	Within Groups	.998	9	.111		
	Total	3.085	11			
Fresh weight of stems	Between Groups	44.774	2	22.387	13.200	.002
	Within Groups	15.264	9	1.696		
	Total	60.038	11			
Dry weight of stems	Between Groups	1.345	2	.673	8.508	.008
	Within Groups	.711	9	.079		
	Total	2.056	11			
Fresh weight of leaves	Between Groups	23.869	2	11.935	6.371	.019
	Within Groups	16.858	9	1.873		
	Total	40.728	11			
Dry weight of leaves	Between Groups	.813	2	.407	4.654	.041
	Within Groups	.786	9	.087		
	Total	1.599	11			
Fresh weight of pods	Between Groups	6.397	2	3.198	13.541	.002
	Within Groups	2.126	9	.236		
	Total	8.522	11			
Dry weight of pods	Between Groups	.053	2	.027	13.073	.002
	Within Groups	.018	9	.002		
	Total	.071	11			

3-Nutrients distribution

Statical analysis was conducted using one way ANOVA test, test divided into two parts ,one of them between cultivars in the same line ,another between every cultivars compared to lines. Table 22 in appendix show ANOVA test for, Artasi , Isbani and Baladi cultivars according to plants parts the output have a statistically significant difference between group means in some nutrients. It was see that the significance level is ($p < 0.05$).

Table 16) ANOVA analysis of nutrients line 1

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
So4	Between Groups	1106.287	2	553.144	.903	.439
	Within Groups	5516.019	9	612.891		
	Total	6622.306	11			
No3	Between Groups	29.510	2	14.755	.090	.915
	Within Groups	1477.307	9	164.145		
	Total	1506.817	11			
Po4	Between Groups	22.628	2	11.314	.335	.724
	Within Groups	303.775	9	33.753		
	Total	326.404	11			
Ca	Between Groups	707.651	2	353.826	.253	.782
	Within Groups	12601.463	9	1400.163		
	Total	13309.115	11			
Cu	Between Groups	.001	2	.001	.090	.914
	Within Groups	.061	9	.007		
	Total	.062	11			
Fe	Between Groups	1.507	2	.754	.066	.937
	Within Groups	103.312	9	11.479		

	Total	104.819	11			
K	Between Groups	654.729	2	327.365	.569	.585
	Within Groups	5181.406	9	575.712		
	Total	5836.135	11			
Mg	Between Groups	456.645	2	228.323	1.956	.197
	Within Groups	1050.379	9	116.709		
	Total	1507.024	11			
Mn	Between Groups	.516	2	.258	.309	.741
	Within Groups	7.502	9	.834		
	Total	8.018	11			
Mo	Between Groups	.008	2	.004	1.727	.232
	Within Groups	.020	9	.002		
	Total	.027	11			
Na	Between Groups	47.711	2	23.856	.587	.576
	Within Groups	365.766	9	40.641		
	Total	413.477	11			
Zn	Between Groups	.003	2	.001	.265	.773
	Within Groups	.043	9	.005		
	Total	.046	11			
Cl	Between Groups	50.519	2	25.259	.559	.590
	Within Groups	406.597	9	45.177		
	Total	457.115	11			

Table 17 ANOVA analysis nutrients in line 2

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
So4	Between Groups	251.991	2	125.996	1.351	.307
	Within Groups	839.599	9	93.289		
	Total	1091.591	11			
No3	Between Groups	5.568	2	2.784	.040	.961
	Within Groups	633.701	9	70.411		
	Total	639.269	11			
Po4	Between Groups	4.182	2	2.091	.355	.711
	Within Groups	53.057	9	5.895		
	Total	57.239	11			
Ca	Between Groups	6194.454	2	3097.227	.815	.473
	Within Groups	34185.777	9	3798.420		
	Total	40380.231	11			
Cu	Between Groups	.000	2	.000	.039	.962
	Within Groups	.033	9	.004		
	Total	.033	11			
Fe	Between Groups	.905	2	.453	.115	.893
	Within Groups	35.569	9	3.952		
	Total	36.474	11			
K	Between Groups	74.417	2	37.208	.077	.927
	Within Groups	4374.833	9	486.093		
	Total	4449.250	11			
Mg	Between Groups	9.187	2	4.593	.081	.923
	Within Groups	511.703	9	56.856		
	Total	520.889	11			
Mn	Between Groups	.067	2	.033	.339	.721
	Within Groups	.884	9	.098		
	Total	.951	11			
Mo	Between Groups	.035	2	.018	1.227	.338
	Within Groups	.130	9	.014		
	Total	.165	11			
Na	Between Groups	49.147	2	24.574	.087	.917
	Within Groups	2528.721	9	280.969		
	Total	2577.868	11			
Zn	Between Groups	.003	2	.002	1.512	.271
	Within Groups	.010	9	.001		
	Total	.013	11			
Cl	Between Groups	4.136	2	2.068	.010	.990
	Within Groups	1813.108	9	201.456		
	Total	1817.244	11			

Table 18 ANOVA analysis nutrients in line 3

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
So4	Between Groups	62.331	2	31.165	.378	.696
	Within Groups	742.235	9	82.471		
	Total	804.566	11			
No3	Between Groups	1.563	2	.782	.026	.974
	Within Groups	268.670	9	29.852		
	Total	270.234	11			
Po4	Between Groups	1.507	2	.754	.127	.882
	Within Groups	53.219	9	5.913		
	Total	54.726	11			
Ca	Between Groups	7674.688	2	3837.344	1.332	.311
	Within Groups	25932.257	9	2881.362		
	Total	33606.945	11			
Cu	Between Groups	.000	2	.000	.002	.998
	Within Groups	.033	9	.004		
	Total	.033	11			
Fe	Between Groups	.732	2	.366	.232	.798
	Within Groups	14.209	9	1.579		
	Total	14.941	11			
K	Between Groups	362.370	2	181.185	.988	.409
	Within Groups	1651.086	9	183.454		
	Total	2013.456	11			
Mg	Between Groups	15.230	2	7.615	.212	.813
	Within Groups	322.807	9	35.867		
	Total	338.037	11			
Mn	Between Groups	.059	2	.029	.385	.691
	Within Groups	.687	9	.076		
	Total	.746	11			

Mo	Between Groups	.036	2	.018	1.234	.336
	Within Groups	.130	9	.014		
	Total	.166	11			
Na	Between Groups	935.932	2	467.966	.348	.715
	Within Groups	12113.434	9	1345.937		
	Total	13049.365	11			
Zn	Between Groups	.015	2	.008	1.018	.400
	Within Groups	.067	9	.007		
	Total	.082	11			
Cl	Between Groups	1009.259	2	504.630	.342	.719
	Within Groups	13275.393	9	1475.044		
	Total	14284.652	11			

Table 19 ANOVA analysis nutrients in line 5

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
So4	Between Groups	.640	2	.320	.015	.985
	Within Groups	188.324	9	20.925		
	Total	188.964	11			
No3	Between Groups	40.647	2	20.323	3.131	.093
	Within Groups	58.413	9	6.490		
	Total	99.060	11			
Po4	Between Groups	.199	2	.100	.836	.464
	Within Groups	1.072	9	.119		
	Total	1.271	11			
Ca	Between Groups	17811.350	2	8905.675	.282	.761
	Within Groups	284522.159	9	31613.573		
	Total	302333.510	11			
Cu	Between Groups	.000	2	.000	.697	.523
	Within Groups	.000	9	.000		
	Total	.001	11			
Fe	Between Groups	.175	2	.087	.074	.929
	Within Groups	10.644	9	1.183		
	Total	10.819	11			
K	Between Groups	7.697	2	3.849	.013	.987

	Within Groups	2708.529	9	300.948		
	Total	2716.226	11			
	Between Groups	75.326	2	37.663	.530	.606
Mg	Within Groups	639.057	9	71.006		
	Total	714.383	11			
	Between Groups	.000	2	.000	.005	.995
Mn	Within Groups	.026	9	.003		
	Total	.026	11			
	Between Groups	.000	2	.000	1.027	.397
Mo	Within Groups	.001	9	.000		
	Total	.001	11			
	Between Groups	6.655	2	3.327	.003	.997
Na	Within Groups	8571.052	9	952.339		
	Total	8577.706	11			
	Between Groups	.001	2	.001	.732	.507
Zn	Within Groups	.008	9	.001		
	Total	.009	11			
	Between Groups	3.382	2	1.691	.002	.998
Cl	Within Groups	8954.227	9	994.914		
	Total	8957.610	11			

Table 20 ANOVA analysis nutrients according to plants part

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
So4	Between Groups	3483.570	3	1161.190	3.872	.015
	Within Groups	13196.237	44	299.914		
	Total	16679.807	47			
No3	Between Groups	580.810	3	193.603	.654	.584
	Within Groups	13017.336	44	295.849		
	Total	13598.146	47			
Po4	Between Groups	181.491	3	60.497	.414	.744
	Within Groups	6436.876	44	146.293		
	Total	6618.367	47			
Ca	Between Groups	146275.640	3	48758.547	5.966	.002
	Within Groups	359588.299	44	8172.461		
	Total	505863.939	47			
Cu	Between Groups	.087	3	.029	15.509	.000
	Within Groups	.083	44	.002		
	Total	.170	47			
Fe	Between Groups	121.876	3	40.625	34.563	.000
	Within Groups	51.718	44	1.175		
	Total	173.594	47			
K	Between Groups	615.891	3	205.297	.235	.872
	Within Groups	38470.229	44	874.323		
	Total	39086.120	47			
Mg	Between Groups	916.326	3	305.442	5.242	.004
	Within Groups	2563.640	44	58.265		
	Total	3479.966	47			
Mn	Between Groups	4.487	3	1.496	9.335	.000
	Within Groups	7.050	44	.160		
	Total	11.538	47			
Mo	Between Groups	.062	3	.021	2.443	.077
	Within Groups	.373	44	.008		
	Total	.435	47			
Na	Between Groups	11962.947	3	3987.649	2.436	.077
	Within Groups	72014.440	44	1636.692		
	Total	83977.387	47			
Zn	Between Groups	.007	3	.002	.419	.740
	Within Groups	.247	44	.006		
	Total	.254	47			
Cl	Between Groups	12566.376	3	4188.792	2.495	.072
	Within Groups	73879.427	44	1679.078		
	Total	86445.803	47			

Table 22

Dependent Variable	(I) plant part	(J) plant part	Mean Difference (I-J)	Std. Error	Sig.
So4	pods	leaves	-2.655774717-	7.070059908	.709
		shoots	-6.169415675-	7.070059908	.388
		roots	-21.955550283-*	7.070059908	.003
	leaves	pods	2.655774717	7.070059908	.709
		shoots	-3.513640958-	7.070059908	.622
		roots	-19.299775567-*	7.070059908	.009
	shoots	pods	6.169415675	7.070059908	.388
		leaves	3.513640958	7.070059908	.622
		roots	-15.786134608-*	7.070059908	.031
	roots	pods	21.955550283*	7.070059908	.003
		leaves	19.299775567*	7.070059908	.009
		shoots	15.786134608*	7.070059908	.031
No3	pods	leaves	-8.141928683-	7.021972103	.253
		shoots	.355959125	7.021972103	.960
		roots	-4.304213150-	7.021972103	.543
	leaves	pods	8.141928683	7.021972103	.253
		shoots	8.497887808	7.021972103	.233
		roots	3.837715533	7.021972103	.587
	shoots	pods	-.355959125-	7.021972103	.960
		leaves	-8.497887808-	7.021972103	.233
		roots	-4.660172275-	7.021972103	.510
	roots	pods	4.304213150	7.021972103	.543
		leaves	-3.837715533-	7.021972103	.587
		shoots	4.660172275	7.021972103	.510
Po4	pods	leaves	3.912608058	4.937824000	.432
		shoots	2.688526283	4.937824000	.589
		roots	-.879136158-	4.937824000	.860

	leaves	pods	-3.912608058-	4.937824000	.432
		shoots	-1.224081775-	4.937824000	.805
		roots	-4.791744217-	4.937824000	.337
	shoots	pods	-2.688526283-	4.937824000	.589
		leaves	1.224081775	4.937824000	.805
		roots	-3.567662442-	4.937824000	.474
	roots	pods	.879136158	4.937824000	.860
		leaves	4.791744217	4.937824000	.337
		shoots	3.567662442	4.937824000	.474
Ca	pods	leaves	-152.990169583-*	36.906325888	.000
		shoots	-70.442048750-	36.906325888	.063
		roots	-99.302514583-*	36.906325888	.010
	leaves	pods	152.990169583*	36.906325888	.000
		shoots	82.548120833*	36.906325888	.030
		roots	53.687655000	36.906325888	.153
	shoots	pods	70.442048750	36.906325888	.063
		leaves	-82.548120833-*	36.906325888	.030
		roots	-28.860465833-	36.906325888	.438
	roots	pods	99.302514583*	36.906325888	.010
		leaves	-53.687655000-	36.906325888	.153
		shoots	28.860465833	36.906325888	.438
Cu	pods	leaves	-.023781833-	.017688133	.186
		shoots	-.008187583-	.017688133	.646
		roots	-.107173583-*	.017688133	.000
	leaves	pods	.023781833	.017688133	.186
		shoots	.015594250	.017688133	.383
		roots	-.083391750-*	.017688133	.000

	shoots	pods	.008187583	.017688133	.646
		leaves	-.015594250-	.017688133	.383
		roots	-.098986000-*	.017688133	.000
	roots	pods	.107173583*	.017688133	.000
		leaves	.083391750*	.017688133	.000
		shoots	.098986000*	.017688133	.000
Fe	pods	leaves	-1.051948583-*	.442608748	.022
		shoots	-.614878083-	.442608748	.172
		roots	-4.132905083-*	.442608748	.000
	leaves	pods	1.051948583*	.442608748	.022
		shoots	.437070500	.442608748	.329
		roots	-3.080956500-*	.442608748	.000
	shoots	pods	.614878083	.442608748	.172
		leaves	-.437070500-	.442608748	.329
		roots	-3.518027000-*	.442608748	.000
	roots	pods	4.132905083*	.442608748	.000
		leaves	3.080956500*	.442608748	.000
		shoots	3.518027000*	.442608748	.000
K	pods	leaves	-8.424262583-	12.071477262	.489
		shoots	.549569510	12.071477262	.964
		roots	-3.607594917-	12.071477262	.766
	leaves	pods	8.424262583	12.071477262	.489
		shoots	8.973832093	12.071477262	.461
		roots	4.816667667	12.071477262	.692
	shoots	pods	-.549569510-	12.071477262	.964
		leaves	-8.973832093-	12.071477262	.461
		roots	-4.157164427-	12.071477262	.732
	roots	pods	3.607594917	12.071477262	.766
		leaves	-4.816667667-	12.071477262	.692
		shoots	4.157164427	12.071477262	.732
Mg	pods	leaves	-11.525989442-*	3.116209105	.001
		shoots	-1.953716358-	3.116209105	.534
		roots	-5.084862692-	3.116209105	.110
	leaves	pods	11.525989442*	3.116209105	.001

		shoots	9.572273083*	3.116209105	.004
		roots	6.441126750*	3.116209105	.045
	shoots	pods	1.953716358	3.116209105	.534
		leaves	-9.572273083-*	3.116209105	.004
		roots	-3.131146333-	3.116209105	.320
	roots	pods	5.084862692	3.116209105	.110
		leaves	-6.441126750-*	3.116209105	.045
		shoots	3.131146333	3.116209105	.320
Mn	pods	leaves	-.073560667-	.163418532	.655
		shoots	.038407767	.163418532	.815
		roots	-.711699833-*	.163418532	.000
	leaves	pods	.073560667	.163418532	.655
		shoots	.111968433	.163418532	.497
		roots	-.638139167-*	.163418532	.000
	shoots	pods	-.038407767-	.163418532	.815
		leaves	-.111968433-	.163418532	.497
		roots	-.750107600-*	.163418532	.000
	roots	pods	.711699833*	.163418532	.000
		leaves	.638139167*	.163418532	.000
		shoots	.750107600*	.163418532	.000
Mo	pods	leaves	.037271500	.037593711	.327
		shoots	-.016846667-	.037593711	.656
		roots	-.062905000-	.037593711	.101
	leaves	pods	-.037271500-	.037593711	.327
		shoots	-.054118167-	.037593711	.157
		roots	-.100176500-*	.037593711	.011
	shoots	pods	.016846667	.037593711	.656
		leaves	.054118167	.037593711	.157
		roots	-.046058333-	.037593711	.227
	roots	pods	.062905000	.037593711	.101
		leaves	.100176500*	.037593711	.011
		shoots	.046058333	.037593711	.227
Na	pods	leaves	-32.197944217-	16.516112438	.058
		shoots	-38.792170967-*	16.516112438	.023

		roots	-37.091580467-*	16.516112438	.030
	leaves	pods	32.197944217	16.516112438	.058
		shoots	-6.594226750-	16.516112438	.692
		roots	-4.893636250-	16.516112438	.768
	shoots	pods	38.792170967*	16.516112438	.023
		leaves	6.594226750	16.516112438	.692
		roots	1.700590500	16.516112438	.918
	roots	pods	37.091580467*	16.516112438	.030
		leaves	4.893636250	16.516112438	.768
		shoots	-1.700590500-	16.516112438	.918
Zn	pods	leaves	-.029730380-	.030608349	.337
		shoots	-.005617480-	.030608349	.855
		roots	-.022758347-	.030608349	.461
	leaves	pods	.029730380	.030608349	.337
		shoots	.024112900	.030608349	.435
		roots	.006972033	.030608349	.821
	shoots	pods	.005617480	.030608349	.855
		leaves	-.024112900-	.030608349	.435
		roots	-.017140867-	.030608349	.578
	roots	pods	.022758347	.030608349	.461
		leaves	-.006972033-	.030608349	.821
		shoots	.017140867	.030608349	.578
Cl	pods	leaves	-33.994045500-*	16.728607631	.048
		shoots	-40.123033250-*	16.728607631	.021
		roots	-36.972661333-*	16.728607631	.032
	leaves	pods	33.994045500*	16.728607631	.048
		shoots	-6.128987750-	16.728607631	.716
		roots	-2.978615833-	16.728607631	.859
	shoots	pods	40.123033250*	16.728607631	.021

		leaves	6.128987750	16.728607631	.716
		roots	3.150371917	16.728607631	.851
	roots	pods	36.972661333*	16.728607631	.032
		leaves	2.978615833	16.728607631	.859
		shoots	-3.150371917-	16.728607631	.851

جامِعةُ النجاحِ الوطنية
كليّةُ الدراساتِ العليا

تأثير المغذيات والملوحة على انتاج، نمو وتوزيع العناصر في الفول المزروع في الزراعة المائية

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قُدِّمَت هذهِ الأُطروحَةُ استكمالًا لمتطلّبات الحصول على درجة الماجستير في العلوم البيئية في كليّةِ الدراساتِ العُليا في جامعة النجاح الوطنيّةِ في نابلس، فلسطين.

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الملخص

يعتبر نبات الفول احد المحاصيل المهمة التي تزرع في فلسطين، حيث ينتمي للعائلة البقولية، ويزرع تقريبا في كل جزء من فلسطين. تكمن أهمية هذا البحث من حيث تركيزه على مصدر مهم للغذاء للحيوان والنبات بالإضافة إلى استخدامه تقنية جديدة في الزراعة الا وهي الزراعة المائية. يهدف هذا البحث إلى دراسة تأثير مستويين من كلوريد الصوديوم (4.68 و 7,8 ديسي سيمنز/م) وثلاثة مستويات من محلول كوبر المغذي (25%، 100% ، 300%) على نمو، إنتاج وتوزيع العناصر في ثلاثة أصناف من الفول (البلدي، الأرطاسي، الاسباني) المزروعة في نظام للزراعة المائية(داخل الأنابيب). قسمت التجربة الى ست مجموعات، ثلاث مجموعات رويت بماء يحتوي ثلاثة مستويات من محلول كوبر المغذي (25%، 100%، 300%)، مجموعتين رويت بمستويين من كلوريد الصوديوم (4.68 و 7,8 ديسي سيمنز/م)، ومجموعة رويت بماء فقط حيث تعتبر المرجع .وكانت كل مجموعة تحتوي ثلاثة أنابيب في كل أنبوب احد انواع الفول الثلاثة. كانت المغذيات تزود للنباتات مرتين يوميا عن طريق نظام للري عبر مرشات ويتم إرجاع الفائض منها إلى داخل البراميل البلاستيكية. بعد أن أتم الفول دورة حياته واخرج الثمار، تم اخذ أجزاءه وجففت وحرقت وتم تحويلها إلى محاليل وتم إجراء التحاليل المناسبة بواسطة عدة أجهزة في المختبر، وأشارت النتائج إلى أن زيادة تركيز محلول كوبر أدى الى زيادة في طول النباتات، مساحة الأوراق، عدد الأوراق وعدد القرون. ولكن الزيادة في تركيز المحلول أدى إلى نقصان في طول الجذور في الثلاثة أصناف مقارنة بالمرجع. لقد وجد انه لايوجد فرق معنوي بين 25% و100% من محلول كوبر فيما يتعلق بالنمو الخضري في

الثلاثة أصناف من الفول، بينما وجد نقص معنوي في النمو الخضري للثلاثة أصناف عند ريها بثلاثة أضعاف محلول كوبر المغذي،إضافة لذلك لم تنتج الأصناف الثلاثة قرون حيث ماتت جميع النباتات في مرحلة ما قبل الإزهار، ودلت النتائج على ان تزويد النباتات ب(4.68 ديسي سيمنز/م) من محلول كلوريد الصوديوم سبب نقصان في طول النباتات، عدد الأوراق ،مساحة الأوراق و عدد القرون، ولكنه أدى إلى زيادة طول الجذور، بينما (7.8 ديسي سيمنز/م) من محلول كلوريد الصوديوم سبب موت النباتات في مرحلة الأزهار لذلك لم تنتج قرون، بالإضافة إلى ذلك وجد نقصان في طول النبات، عدد الأوراق،مساحة الأوراق، ونقص معنوي في طول الجذور. لم يوجد فرق معنوي بين (4,68 و7,8 ديسي سيمنز/م) من محلول ملح الطعام في النمو الخضري باستثناء عدد القرون وطول الجذور.

من جهة أخرى أشارت النتائج إلى زيادة معنوية في الوزن الرطب والجاف للنمو الخضري للثلاثة أصناف مقارنة بالنبات المرجع ،عندما زودت بمحلول كوبر المغذي، حيث لوحظ عدم وجود فرق معنوي بين 25% و100% من محلول كوبر، بينما تطبيق 4.68 ديسي سيمنز/م أدى إلى زيادة غير معنوية في الوزن الرطب والجاف للنمو الخضري مقارنة مع الخط المرجع.

تبعا لنتائج تحليل أجهزة التحليل الطيفي(FP) وجهاز التحليل الطيفي الكتلي (ICP-MS) للثلاثة أصناف من الفول، التحليل شمل أربعة خطوط فقط ،الخط الأول، الثاني، الثالث، بالإضافة إلى الخامس(المرجع)، الخط الأول(100% كوبر) سجل أعلى قيمة ل NO_3, SO_4, PO_4, K, Zn, Mn, Mo مقارنة بالخطوط الأخرى،الخط الثاني(25% كوبر) اظهر نقصان في محتوى المغذيات ، بالرغم من ذلك لم يوجد فرق معنوي بين الخط الأول والثاني في محتوى المغذيات.

في الخط الثالث (4.68 ديسي سيمنز /م NaCl) وجد زيادة معنوية في Na وCl وزيادة غير معنوية في بعض المغذيات مثل Mn,Cu,SO_4,NO_3,PO_4 ،بعض المغذيات مثل Cu, Mg لم تظهر فرق معنوي بين الخطوط ،Ca ازداد في الخط الخامس والثالث ولكنه تناقص في الخط الاول والثاني، ولم توجد فروق معنوية بين الأصناف الثلاثة داخل الخطوط الأربعة.

بالنسبة لتوزيع العناصر في أجزاء الثلاثة أصناف من نبات الفول، أظهرت النتائج زيادة في بعض العناصر في الجذور مثل :SO_4,Fe,Zn,Mn,Mo ،بعض العناصر تركزت في الجذور والأوراق مثل: NO_3,Cu, Mg بينما Na وCl تراكم في الجذور والسيقان، PO_4 تراكم في الجذور والقرون، بالإضافة إلى ذلك تراكم Ca في الأوراق، أشارت النتائج إلى عدم وجود فرق معنوي بين المغذيات في أجزاء الثلاثة أصناف من الفول.

نستنتج مما سبق ان الفول البلدي والاسباني أكثر مقاومة للملوحة من الارطاسي لذلك تعتبر خيارات جيدة للزراعة في المناطق التي تعاني من ملوحة متوسطة، تأثير المغذيات كان ايجابيا حيث أدى إلى زيادة في النمو الخضري والإنتاج، لكن زيادة المغذيات عن حد معين أدى إلى نتائج سلبية على النمو الخضري والإنتاج،كذلك تأثر النمو الخضري والإنتاج سلبيا بالملوحة.

تعتبر الزراعة المائية طريقة جديدة وناجحة للزراعة في عدة مناطق من العالم وهناك حاجة لتطبيق هذا النظام على مساحة واسعة في فلسطين، والفول احد النباتات التي يمكن زراعتها داخل هذا النظام لكنه غير مجدي اقتصاديا بالنسبة للزراعة الفول لذلك يوصى بزراعة محاصيل اخرى مثل الفراولة. و تعتبر الزراعة المائية وسيلة جيدة للأبحاث الزراعية حيث يمكن التحكم بكافة الظروف المحيطة.