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SIIRT UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF HORTICULTURE

EFFECT OF SEAWEED EXTRACT APPLICATION ON THE GROWTH, FLOWERING AND FRUIT CHARACTERISTICS OF STRAWBERRY (*FRAGARIA X ANANASSA* DUCH) CV ALBION GROWING IN IRAQ CONDITIONS

MASTER DEGREE
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JANUARY-2018
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THESIS ACCEPTANCE AND APPROVAL

The thesis study entitled "Effect of seaweed extract application on the growth, flowering and fruit characteristics of strawberry (*Fragaria x ananassa* Duch) cv Albion growing in Iraq condition" prepared by Abdulla Hama Najib AL-SHATRI has been accepted as a Master's Thesis at Siirt University, Institute of Science and Technology, Department of Horticulture, by unanimity/~~majority~~ of votes by the following jury at 29/01/2018

Jury Members	**Signature**
President Assoc. Prof. Dr. Halil İbrahim OĞUZ	.....
Supervisor Assist. Prof. Dr. Mine PAKYÜREK	.....
Member Assist. Prof. Dr. Halit Seyfettin ATLI	.....

I confirm the above conclusion.

Prof. Dr. Koray ÖZRENK
Director of the Institute of Science and Technology

THESIS NOTIFICATION

I hereby say that this paper is my unique authorial actions, which I have worked out by my own. Every information bases references and literature used or excerpted through explanation of this work are correctly cited and listed in complete reference to the owing cause.

Signature

Abdalla Hama Najib AL SHATRI

Note: In this thesis, the use of original and different source notifications, tables. Figures and photographs without signal, it is subject to provision of law No 5846 on Intellectual and Artistic Works.

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With my Regards ...

Abdalla Hama Najib AL-SHATRI

LIST OF CONTENTS

LIST OF TABLES

page

LIST OF FIGURES

ABBREVIATIONS AND SYMBOLS

Abbreviation	Explanation
g	**:** Gram
cm	**:** Centimeter
ml	**:** Milliliter
m	**:** Meter
mm	**:** Millimeter
TSS	**:** Total Soluble Solids
TA	**:** Total Acidity
NaOH	: Sodium hydroxide
RCBD	**:** Randomized Complete Block Design
$g.L^{-1}$	**:** Gram per one liter
MRT	**:** Multiple range test

Symbol	Explanation
°C	**:** Degrees Celsius
%	**:** Percent

ÖZET

YÜKSEK LİSANS TEZİ

IRAK KOŞULLARINDA YETİŞTİRİLEN ALBION ÇİLEK (*FRAGARIA X ANANASSA* DUCH) ÇEŞİDİNDE DENİZ YOSUNU EKSTRAKTININ UYGULAMASININ BÜYÜME, ÇİÇEKLENME VE MEYVE ÖZELLİKLERİ ÜZERİNE ETKİSİ

Abdalla Hama Najib AL-SHATRI

Siirt Üniversitesi Fen Bilimleri Enstitüsü

Bahçe Bitkileri Anabilim Dalı

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2018, 72 Sayfa

Bu çalışma, Kuzey Irak'a bağlı Süleymaniye ilinin Kalar ilçesinde deniz yosunu ekstraktının (Alga 600) dört farklı dozunun (0,2,4,8 gL^{-1}) Albion çilek çeşidinde büyüme, çiçeklenme, verim ve kalite özellikleri üzerindeki etkisini araştırmak amacıyla 2017 yılı vejetasyon periyodunda saksı denemesi olarak kurulmuştur. Sulamada damla sulama sistemi kullanılmıştır. Çalışmada vejetatif gelişim açısından elde edilen sonuçlar incelendiğinde, taç yaprak oluşumunda artan yosun ekstresi (Alga 600) uygulamasının, kontrol uygulamasından istatistiksel olarak farklı olduğu bulunmuştur ($p<0,01$). Çiçek özellikleri ile ilgili sonuçlar ise, artan yosun ekstraktı uygulamasının bitki başına düşen çiçek sayısı bakımından 16.55 adet/bitki ile 21.77 adet/bitki arasında değiştiğini göstermektedir ($p <0,05$). Meyve özelliklerine ilişkin sonuçlar ise, Alga 600'ün artan dozlarının, bitki başına düşen meyve sayısının 11,81 adet/bitki ile 17,7 adet/bitki aralığında değiştiğini gösterirken ($p<0.05$); toplam meyve hacminin 211,74 ml ile 329,37 ml arasında değişkenlik gösterdiği ve bitki başına düşen verimin 191,7 g ile 295,03 g arasında değerlere sahip olduğunu göstermektedir ($p<0.05$). Bunun yanında, artan yosun ekstraktı dozları meyve kalitesi üzerinde belirgin bir artışa neden olurken (SÇKM / TA oranının 8,29'dan 13,35'e yükseldiği), kontrol grubu ile mukayese edildiğinde de belirgin bir düşüşe neden olduğu görülmektedir ($p<0.05$). Makro ve mikro elementlerin analiz sonuçlarına göre de çiçeklenme döneminde yaprakta bulunan manganez içeriğinin önemli olduğu tespit edilmiştir ($p<0.05$).

Anahtar Kelimeler: çilek, organik gübreleme, deniz yosunu, Albion, vejetatif büyüme, çiçeklenme, pomolojik özellikler.

ABSTRACT

MS THESIS

EFFECT OF SEAWEED EXTRACT APPLICATION ON THE GROWTH, FLOWERING AND FRUIT CHARACTERISTICS OF STRAWBERRY (*FRAGARIA X ANANASSA* DUCH) CV ALBION GROWING IN IRAQ CONDITIONS

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Abstract

This experiment was established in pots during vegetative period of 2017, in Kalar Sulaymaniyah, North of Iraq, to investigate the effect of seaweed extract (Alga 600) of four concentrations (0,2,4,8 $g.L^{-1}$) by fertigation system on growth, flowering, yield and quality properties of strawberry cv. Albion., Drip irrigation system was used for irrigation of the plants. As we come to the results in terms of the vegetative growth characters, increasing seaweed extract (Alga 600) amounts was found different statically on number of crown ($p<0,01$). The results with regard to flower properties show that increasing seaweed extract applications are significant on number of flower per plant from 16,55 units/plant to 21,77 units/plant ($p<0,05$). The results in point of fruit properties show that increasing Alga 600 amounts caused to significant increasing on number of fruit per plant from 11,81units/plant to 17,7 units/plant ($p<0.01$) and total volume of fruit from 211,74 ml to 329,37 ml $p<0.05$) and show the significant increasing on yield properties per plant from 191,7 g to 295,03 g compare with control treatment ($p<0.05$). The results show that increasing seaweed extract caused to significant increasing on fruit qualitative (TSS/TA ratio from 8,29 to 13,35) compare with control treatment and increasing seaweed application caused to significantly decreases on TA in the fruit ($p<0.05$). According to the macro and micro elements analyses results, the effect of the manganese content in leaf at flowering stage was also found significant ($p<0.05$).

Keywords: strawberry, organic fertilization, seaweed, Albion, vegetative growth, flowering, pomological properties.

1. INTRODUCTION

Strawberry (*Fragaria* x *ananassa* Duch.) is small fruit that planted in wide range in the world, it is belongs to family *Rosacea*. Before to the relatively modernity development of *Fragaria x ananassa*, wood strawberries (*Fragaria vesca*) and Musky strawberries (*Fragaria moschata*) were cultivated in Europe and Russia for centuries. These species were in generally supplanted by cultivation of *Fragaria x ananassa* over the last 250 years. In the early 1700s, inter-planting of *Fragaria virginiana* (male) with *Fragaria chiloensis* (female) in France led to production of hybrid seedlings that bring to be known as Pineapple or Pine strawberry plants, progenitors of the new cultivated strawberry plant, (*Fragaria x ananassa* Duch) (Darrow,1966). It is a rich source of vitamins and minerals with delicate flavor (Sharma, 2002). It is one of the most delicious and refreshing temperate fruits of the world. It gives early and very high returns per unit area compared to other fruits because its crop is ready for harvesting within six months after planting (Katiyar et al., 2009). Being a non-climacteric, it matures only on plant (Cordenunsi et al., 2003). Its fruits are appealing with a distinct, enjoyable and refreshing aroma. It also contains a higher percentage of another components including phenolic and flavonoids (Häkkinen and Törrönen, 2000). Strawberry is a perfect source of Vitamin-C (30-100mg/100g of fruit) as well as foliate and photochemical compound such as the Alganic acid. Consuming strawberries can reduce the risk of increasing cancer by 50% due to higher levels of Vitamin-C. Can increase the flow of blood and oxygen to the muscles by 7% due to nitrates (Kumar et al., 2013). Strawberry contains 90% water and 37% calories, 0.7 grams of protein, 0.5 g of oil, 10 g of carbohydrate, 1.3 g fiber and vitamins, contain vitamin A (0.07 mg), vitamin B1, B2 (0.3 mg), niacin (28 mg) and calcium (27mg) (Watt et al.,1963).

Strawberry can be cultivated in almost all regions e.g. from arctic to tropic regions (Hancock, 1999). Including sub-tropical areas like North of Iraq. Country's weather is favorable for the production of high quality strawberries though it is normally produced in countries having cold weather particularly in north. Strawberry cultivation technique is fairly new in North of Iraq whereas cultivation area is increasing bit by bit. Strawberry can be grown during month of October to April in North of Iraq. A sustainable variety is needed for the continuous production from year to year. Screening of strawberry variety is needed for

suitable variety for continuous production and some varietals screening has also done. Today, strawberries are produced in almost every country in the world, most notably, Turkey, America and Iran. This wide distribution suggests that the strawberry plant is great adapted, and as a genus, this is true. However, a lot of individual genotypes or cultivars of strawberries are accurately adapted to local conditions, and so choosing cultivars that are proven to perform well in your specific region is important and key of the work. Strawberry reproduction, fruit quality and yield depend on a lot of factors, e.g., weather conditions during the growing stage, the cultivar and all agronomic practices such as fertilization, irrigation or crop protection (Gulsoy and Yilmaz, 2004).

Cultivated strawberry (*Fragaria x ananassa*) and wild strawberry (*Fragaria virginiana*) are plants in the family of *Rosacea*. The fruit of the strawberry plant is composed of several tiny fruits that together produce the whole fruit, where every small fruit has one seed called achene.

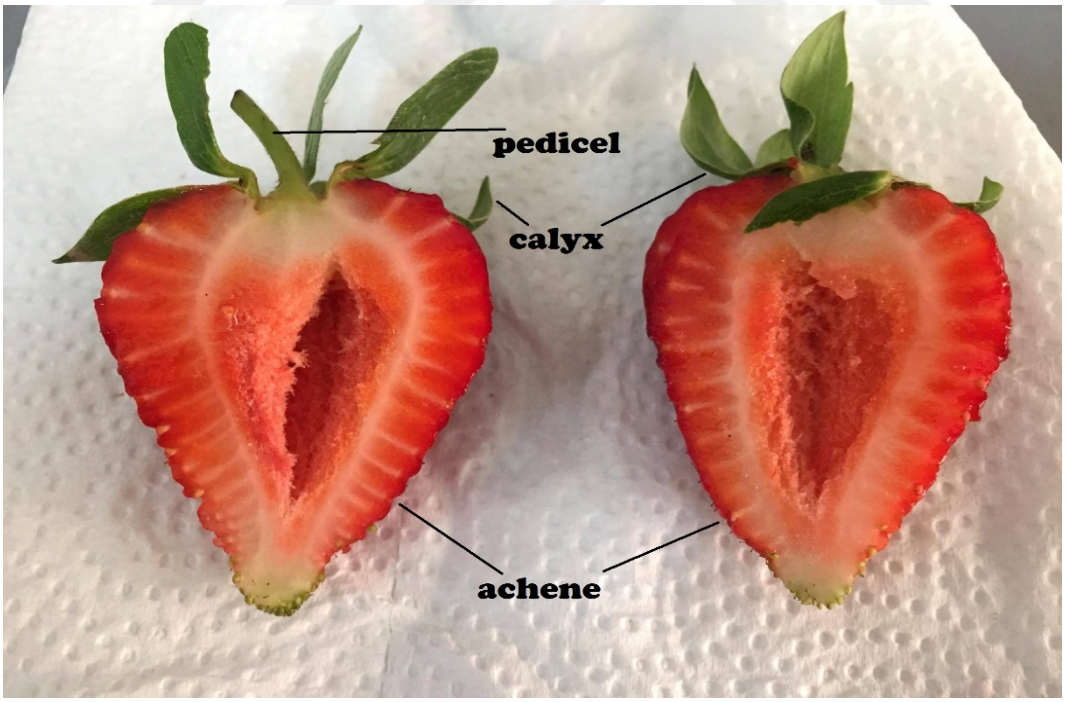

Figure 1.1. Strawberry cv. Albion structure

Strawberry fruit is recognized for its delicate flavor and rich vitamin content. The fruits are used for both shape as fresh fruit and processed in manufactures. In 2009, more than 4.1 million tons of strawberries were produced worldwide (Tangen, 2013). The nutrient profile of strawberries especially content of high micronutrients makes them a healthy food choice (Tangen, 2013).

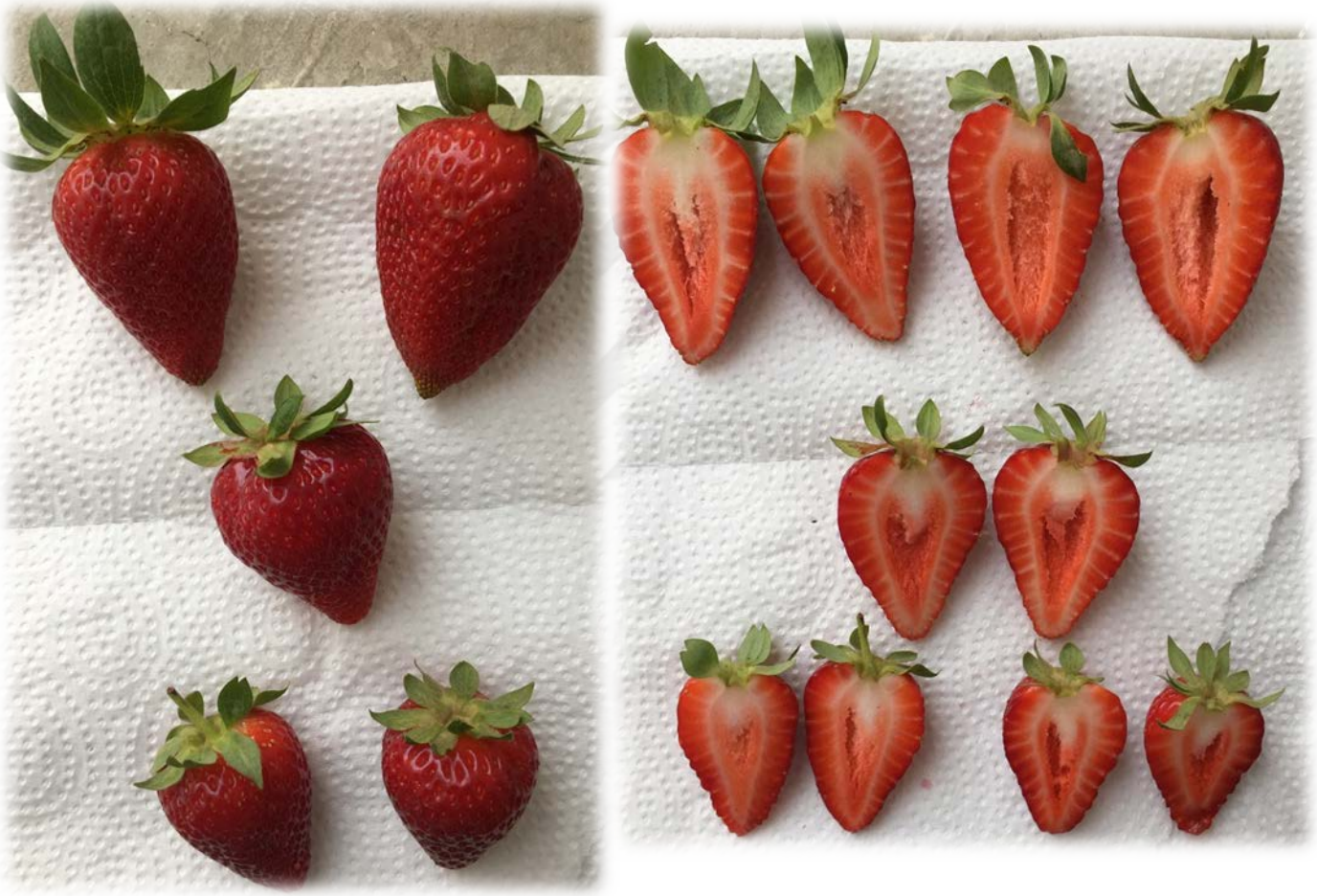

Figure 1.2. Strawberry cv. Albion.

Seaweed extracts are the cheap source of naturally occurring plant development regulators which have better potential as bio stimulants in horticulture. The plant growth regulators available in the seaweed extracts and concentrates is thought to be involved in the enhancing plant growth and yield. Different plant phytohormones and growth regulators available in seaweed extracts are known to promote the yield and yield attributes of crops.

Because the extract contains natural plant hormones and deferent natural nutrient material, vitamins, carbohydrates such as Alganic acid, polysaccharide, trace minerals and etc. (Panda et al., 2012).

The aim of this study, to investigate the effect of seaweed extract (Alga 600) on vegetative growth, flowering quantitative and qualitative parameter of yield on strawberry cv. Albion in Iraq conditions.

2. LITERATURE REVIEW

2.1. General Overview Seaweed Extract:

Seaweed extract is an organic substance that is concentrated and can be found in liquid or soluble granule form. It is mixed with water and added to seeds, transplant and plant to fertilize it. Accordingly, as it has been remarked by Aitken and Senn (1965) it can also replace nutrition deficiencies of plant development

2.2. The Importance Of Using Seaweed Extract On Agriculture:

Seaweed extract is an important substance because it is safe to use. It does not have dangerous side effect on human being, animal and land. In addition to that is reduces land pollution and the rate of soil salt inside soil (Eman, 2008). It is also economic to use since it won't cast too much. For the above mentioned reason it has been a preferred fertilizer throughout centuries **(**Temple and Bomke,1988).

2.3. Effect Of Seaweed On Vegetative Growth And Flowers Properties:

Seaweed extract, in its different types and methods of application, has been a catalyst of plant growth and productivity. As it has been concluded in different studies, seaweed has led to the active development of plants through improving photosynthesis, activating flower, leaves, promoting shoots, leaf minerals and carbohydrates, vegetative weights. As it has been remarked by Masny et al. (2004) in a study leaves activity improves and photosynthesis will be in a better quality when seaweed (Kelpak SL and Goemar BM86) with three treatments (0, 0.5 and 1 $ml.L^{-1}$) is sprayed on the leaves of strawberry. It also promotes the increase of the number of flowers in each plant. This experiment is done on strawberry plants cv. (Elkat and Salut) form 2001-2003. It is also stated it activates shoot growth, the area of leaves a long with the chemical components of leave such as carbohydrates and minerals of the leaf. As it is mentioned by Mansour et al. (2006) in an experiment when algae extract added to the sandy soil of thirty Anna apple trees aged 12 years on MM106 rootstock cultivated at 3.5 x 3.5 m. The effect of extract is shown in other studies again remarks its positive effect on plant growth. Eman and Abd- Allah (2008) in a study show the positive effect of extract. The result

of spraying green alga cells extract on grapevine is shown in comparison with other nutrition fertilizers. The use of alga extract at 25 to 100 % had improved on the growth characters, including the leaf area, shoot length and promoted leaves number in each shoot rather than check treatment.

The development and activation of leaves noticed when alga extract concentration was under 50%. But with concentration above 50% its effect on increasing percentage N, P and K in the leaves is less than under 50%. Other studies also indicate the positive effect of extract on plant production and leaf improvement. Taha (2008) in a study exposes the influence of spraying three seaweed extracts (Algren, Soluamine, Mannarine) in two types of Strawberry (Hapil and Kaiser's samling). It is concluded that the spraying cv. Kaiser's sampling with seaweed (Algren) stimulates an increase in the total chlorophyl1 content and obvious enhance in pollen viability ratio, whereas spraying extracts Soluamine has boosts flower in each plant more than non- applicant ones, as for the cv. Hapil when using Algren extract, there was an increase in dry weight of shoots and leaf area and important superiority of crown diameter, However spraying extract Soluamine there was an increase in the rate of fresh weight of shoot and dry weight of the root system.

Algae extract increases productivity in strawberry as found by AI-Hermizy (2011) in a study. That deals with the effect of sea algae extract (Alga 600) in two levels (0 and 3 $ml.L^{-1}$) on strawberry growth as far as productivity concerned. The outcome of the study shows that spraying with sea algae extract (Algae 600) caused a significant increasing in all vegetative growth characteristics (crown diameter, total leaf aria, fresh and dry weight of vegetative growth, number of runner and number of leaflet per plant). Accordingly, Mac et al. (2008) studied the influence of algae Green (cold process seaweed liquid extract), as foliar fertilization on the plots of mature "Bramley's seedling" apple trees in comparison of other non-applicant trees. It is found that seaweed caused a significant increase in the leaf mineral content.

2.4. Effect Of Seaweed On Fruits Quantities And Qualitative Properties.

Seaweed can be defined as a fertilizer that makes plant prolific in terms of quantity and quality. As it has been proved in different studies seaweed extract has helped the increase in the rate of fruit weight, size, number. It promotes them to be prolific. As affirmed by Kivijarvi et al.(2002) in a study done on strawberry (Jonsok, Ruukki and Bounty) with different concentrations of seaweed extract that resulted in the improvement of the rate of fruit weight and size, quantity of yield.

There is also positive outcome of studies done by Ali et al. (2003) states that the application of nitrogen, phosphors fertilizers and biological stimulators (Seaweed extract) to Strawberry plant cv. (Tuft) leads to the increase in number of fruit per plant, fruit weight and yield per area, the best value were obtained, with the interaction of 50 kg N + 100 kg P + 20 kg biological stimulators per dunam.

There is also positive outcome of studies done by Prokkola and Kivijarvi (2007) In a study that has taken two years from 2001-2002 has found that the fruit quality of strawberry has increased after the usage of seaweed, when tested the usage of seaweed (Ascophyllum nodosum) at level 1 % on the fruit quality and fruit quantity of strawberry cv. 'Jonsok', Similarly Taha (2008) has tested the benefit of spraying of three variety of seaweed (Algren, Marmarine, Soluamine) in two species of strawberry (Kaiser's samling and Hapil). She found out that spraying cv. Kaiser's samling with (Algren) caused to outstanding increase the pollen viability ratio and total yield per unit area, while extract Marmarine caused to decrease the number of fruits to the extent that not suitable for selling. As for the cv. Hapil When using Algren extract there was an increase in size and weight of fruit.

There is also positive outcome of studies done by Al-Hermizy (2011) in search of the impact of seaweed (Alga 600) in two scale (Zero, and 3 $ml.L^{-1}$) on yield properties of strawberry. The outcome indicated that Spraying with seaweed algae caused a significant increasing in every yield characteristic (fruit weight, size, yield per plant, total yield). Again in other studies like Esbgbi et al.,2013 there is prolific result of using foliar application of seaweed extracts including Algren at 0, 3, 6 and 9 $g.l^{-1}$, Drin at 0, 0.5 ,1 and 2 g. l^{-1} focus on

quality fruits of strawberry cv. Selva. The outcome shows that the Algren at $g.l^{-1}$ focus produce the better chlorophyll content.

3. MATERIAL AND METHOD

3.1 . Material

3.1.1 . Location

This study has created out during growing seasons of 2017 in open area. Kalar as Sulaymaniyah, North of Iraq, located between latitude N 34.62131°, longitude E 45.31961°and on elevation (200 m) above sea level.

3.1.2 . Characterizations of Albion

Albion send out in 2006 from the University of California. Farmers report from the Mid-Atlantic are positive regarding the quality, in spite of low yields. This plant produces a high proportion of marketable fruit that are quite firm and even endure prolonged wet period. Due to its volume and shape. This plant has an ideal red color and has acceptably perfect flavor when the fruit is mature. This plant is very strong, and produce a higher number of daughter plant and stolon (Lantz et al.,2010).

Figure 3.1. Strawberry cv. Albion at flowering stage.

Plants producing many of foliage, the fruit can be chosen very fast due to very large size of fruit. This plant is resistant to verticillium wilt, and is moderately oversensitive to fruit anthracnose and powdery mildew (Lantz et al.,2010).

Figure 3.2. Strawberry cv. Albion at fruit stage.

Strawberry cv Albion classified as day neutral because have ability start flowering and buds under various day lengths, plant operation do reply to day length, when temperature and light intensity are equal, ever bearing strawberries produce more flowers, fruit, daughter plant and stolon during long days compared with shorter days (Lantz et al.,2010).

Strawberry species share similar life histories; they are small plant, perennial herbs capable of both sexual reproductions through flowering and unsexual reproductions through (stolon or runner) or crown divisions in an old plant that have a more than on crown Figure 3.3 (Johnson et al.,2014).

Figure 3.3. Strawberry cv. Albion that have a six (6) crown.

3.1.2.1 . Laves

Strawberries cv. Albion have a large complex leaves in which the blade is split into three different leaflets it called a (trifoliate) Figure 3.4.

Figure 3.4. Strawberry cv. Albion leaves, 3 separate leaflets it called a (trifoliate).

The water takes up from the root to leave by evaporation system through pores called stomata that have in stems and leaves. strawberry leaves have a large numbers of stomata, and it need more water in warm periods in middle to late of April and May. Strawberry have a shallow root system and the root located in 15cm in upper layer of soil)

3.1.2.2 . Strawberry flower

Flower is basically made of four, two of them is vegetative part and other is sexual part .The vegetative part is, sepal that forming the calyx and petals that forming corolla .The sexual part is stamens which produce pollen grains containing male gametophytes(anther ,filament) and carpels which produce ovules containing female gametophytse (stigma,style,ovary) Figure 3.5.

The strawberry inflorescence like a cluster which is content of terminal modified stem that have primary flower or fruit and lateral stem that have secondary and tertiary flower or fruit like Figure 3.7. Individual flower is typically content of five petals, ten sepals, and 60-600 pistols, and 20-30 stamens, watch Figure 3.6. It depending on the flower of strawberry variety (Hancock., 1999).

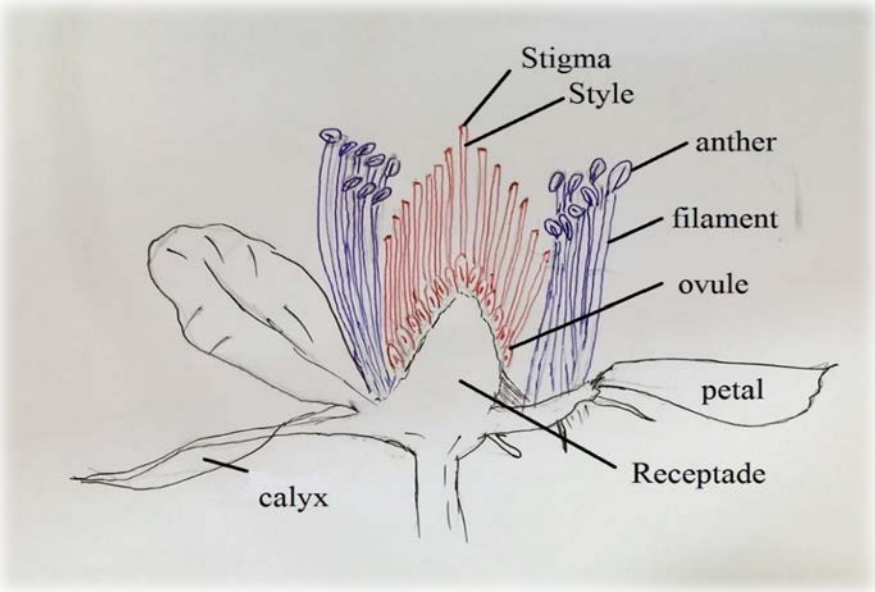

Figure 3.5. Flowers part of Strawberry cv. Albion.

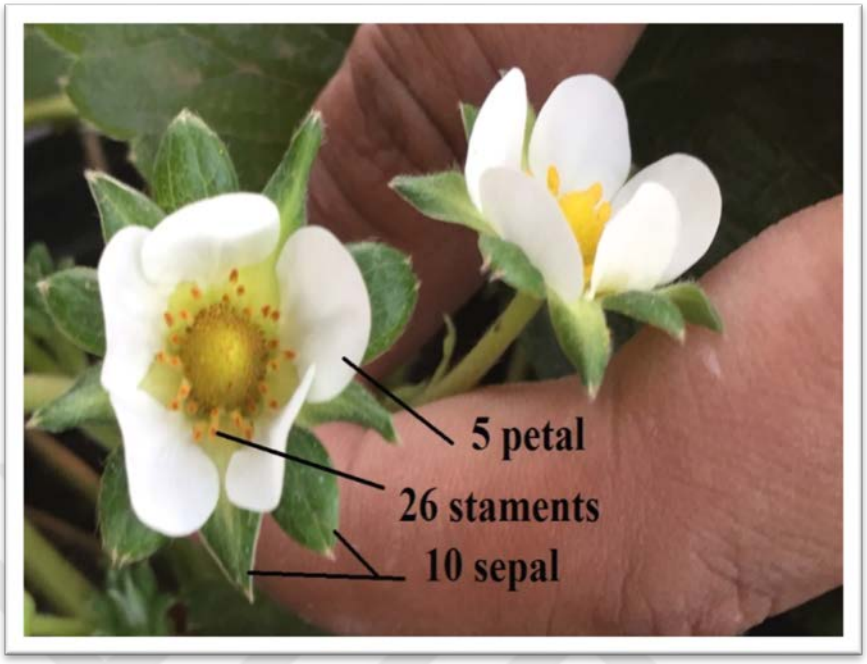

Figure 3.6. Number of sepals, petals and stamens Strawberry cv. Albion flowers.

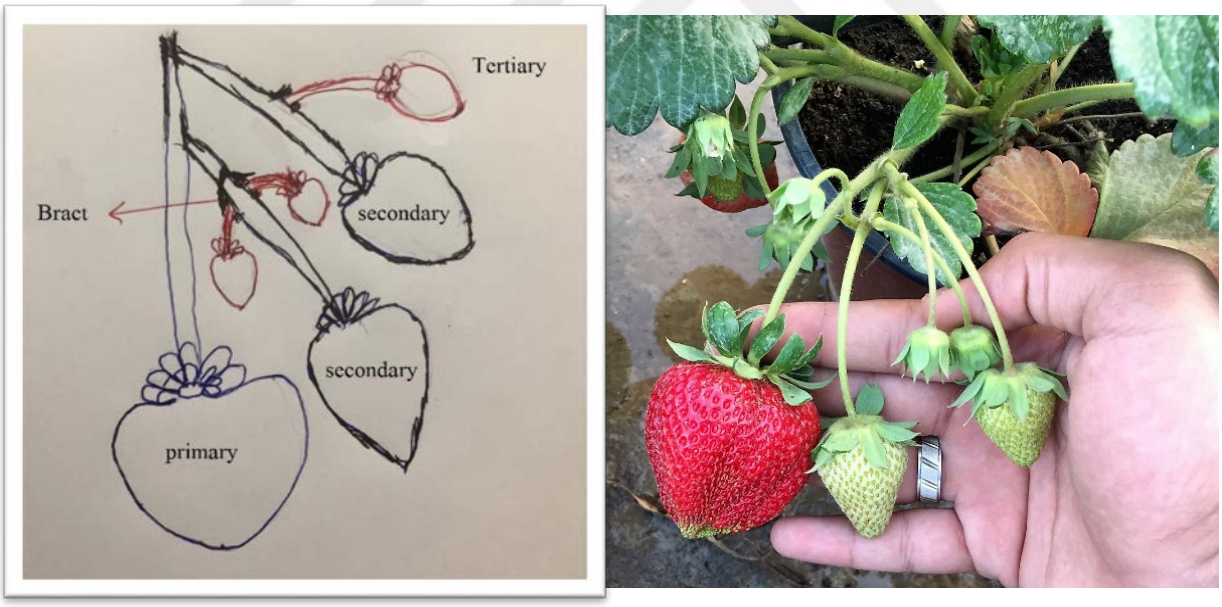

Figure 3.7 Cluster of Strawberry cv. Albion inflorescences.

3.2 . Method

The inspected strawberry plants were cv. Albion in which get at (1/1/2017) from Antalya/ Turkey Figure 3.8. At first of all transplants when pruned by removing damaged leaf and excess and remaining 3 leafs on every plant as well as pruning root system to obtain the balance between vegetative growth and root system Figure 3.9. And we used Nematicide – Insecticide (Ethoprophos 20% w/v) for the root system Figure 3.10. Strawberry plant transplanted in pots capacity 5 kg in open area. At 15/1/2017 start to flowering and at 22/1/2017 start produce runner but we removed flower and runner for more vegetative growth. Every plants enter in this study we do it the uniform horticultural practices that usually executed in the commercial strawberry farms. When the color of fruit reached between 80 to 95% we start to record harvesting data.

Figure 3.8. Strawberry cv Albion after two day of packaging from Antalya/ Turkey to Kalar/Iraq.

Figure 3.9. Strawberry cv. Albion pruning roots to get the balance between roots and vegetative growth.

Figure 3.10. Nematicide – Insecticide (Ethoprophos 20% w/v) used for the root system.

3.2.1 . Treatment

Four concentrations of fertigation solutions (0, 2 ,4 and 8 $g.L^{-1}$) were ready from seaweed (Alga 600). The prepared solutions were applied as fertigation in flowering stage and after first fruiting and twenty days after second using. we dissolved the seaweed (alga 600) in (22 ^{o}C) of water for better fixing. Fertigation application of Seaweed extract (Alga 600) happened in the morning. The Seaweed extract (Alga 600) materials are shown in the (table 3.1) below:

Table 3.1. Components of seaweed (Alga 600), this component is writing on the fertilizer plastic container table.

1	Nitrogen N	0.5-1.0%
2	Alganic acid	6-9%
3	sulfur (S)	1.0-1.5%
4	Phosphorus pentoxide (P_2O_5)	6-9%
5	Calcium oxide (CaO)	0.4-1.6%
6	Iron (Fe)	0.15-0.3%
7	Magnesium oxide (MgO)	0.06%
8	potassium oxide (K_2O)	21-24%
9	Amino acid	4%
10	PH	9-11
11	Organic matter	40-50%

Therefore, the experiment consists of twelve experimental units, four treatments (0,2,4, and 8 g. L^{-1}). With three replications and each experimental unit content of nine plant, by using (RCBD). The comparation of treatments according to standard of portability, **: $p<0.01$, significant at 0,01 level; *: $p<0.05$, significant at 0,05 level an NS: not significant (Agresti, 2010).

3.2.2 . Medium of strawberry planting

We are used peat moss for thesis and planted Strawberry cv Albion in pots, the pots capacity 5 Kg, some chemical properties and physical properties of peat moss available in Table 3.2.

Table 3.2. chemical properties and physical properties of peat moss.

materials	No	materials	readability
physical properties	1	Water holding capacity (g water /100 g dry matters)	600-1000
	2	Humidity % (g/100 g fresh substance)	max-600
	3	Density (Kg/m^1)	200-320
	4	Air volume % (ml air /100ml fresh substrate) at 10 cm	7-13
	5	Particle size	0-40mm
	6	Organic matter % (100 g dry matters)	90-100
chemical properties	1	P (mg^{-1})	35-105
	2	Ca (mg^{-1})	600-1200
	3	Mg (mg^{-1})	200-600
	4	Conductivity (µS/cm)	220-550
	5	N- NO_3 (mg^{-1})	80-180
	6	N-NH_4 (mg^{-1})	30-70
	7	PH	5.5-6.5
	8	K (mg^{-1})	105-195
	9	Fe (mg^{-1})	0-5
	10	SO_4 (mg^{-1})	0-400
	11	Mn (mg^{-1})	0-8

This test sends out in Europe Norm 12580

3.2.3 . Horticulture practices of our experiment

3.2.3.1 . Pollination

Strawberry have both part of sexual production male which is stamens and female which is stigma Figure 3.5. Strawberry are self-fruitful but it need assistance od pollinator like bees or wind, it doesn't need to cross pollination but usually it useful for prepper biter quality and quantity of fruit. In my experiment pollination occur throat the honey bees Figure 3.11 because saw honeybee daily on my strawberry.

Figure 3.11. Honey bee on Strawberry cv. Albion flower at 10 o'clock am.

3.2.3.2 . Insect and diseases

Strawberry are attracted to many of fungus diseases such as gray mold and root rot, and serval kind of insects such as tarnished plant bugs and strawberry bud weevils and other insect and diseases (Fang et al.,2012; Guerena and Born, 2007). The strawberry cv. Albion it has a resistance for virticillium wilt and anthracnose crown rot and have resistance to phytophthora crown rot (Shaw and Larson, 2006). So in my experiment attracted to some diseases and insect, that I wanted to talk about him.

3.2.3.3 . Plant protection

First of all, using Nematicide – Insecticide (Ethoprophos 20% w/v) for the root system Figure 3.10, applied this at the time of transplanting, putted the root of strawberry to (Ethoprophos 20% w/v) in the concentration 50/1000 ml diluted in water for a 5 second Figure 3.12 for prevent the root system to insect and nematode**.**

3.2.3.3.1 . White fly

Saw white fly Figure 3.13 than spared (Thiocyclam hydrogen oxalate 50% wp) in this concentration 2gm/1000ml to strawberry shoot system twice in the early morning, do not applied irrigation in this day for remain mode of action of insecticide, but the whitefly is not completely controlled so used yellow trap as an organic insect control Figure 3.14, (Berlinger, 1980; Pinto-Zevallos and Vänninen, 2013; Böckmann et al.,2015).

3.2.3.3.2 . Fungus disease (leaf scorch and leaf spot)

Saw the fungus disease (leaf scorch and leaf spot), leaf spot it caused by fungus (*Mycosphaerella fragariae*) attached to leave, it was small reddish-purple to dark purple, round spots, 3 to 6 millimeter. the center of spots is a white like a Figure 3.15 and 3.16, (Paulus, 1990; Masny and Żurawicz, 2010; Heidenreich and Turechek, 2016). Leaf scorch is caused by fungus (*Diplocarpon earliana*) it is infected to the leave, it was angular to circular spots appear no upper leaf surface, it was similar to early stage of leaf spot but the different is the center of spot is becoming a black Figure 3.17, it was effected to reduce the vegetative growth and fruit yield (Yamada et al.,2013).

Controlled this two fungus disease by used TERX 800 (fosetyl aluminum) Figure 3.18. using 2 grams/1-liter water of fosetyl aluminum, at 2pm in 12 °C, humidity 48% and wind speed 6 km/hr. (yahoo wither app).and two week later for best results.

3.2.3.3.3 . Aphid

Saw aphid in lower part of leave in my experiment Figure 3.19, (Dagg., 2002; Rondon and Cantliffe, 2005; Tilmon et al.,2011).

Controlled aphid in the beginning stage so it doesn't have an effect of my experiment by using (Acetamiprid 20% (W/W) (A.I)) (Prabhavathi et al,2016).

Figure 3.12. Putted the root of Strawberry cv. Albion to (Ethoprophos 20% w/v) in the concentration 50/1000 ml diluted in water for a 5 second.

Figure 3.13. White fly on the leave surface of Strawberry cv. Albion.

Figure 3.14. Yellow trap that attracted to some insect.

Figure 3.15. Strawberry cv. Albion, leaf spot (fungus disuses) symptom on leaf surface, at the time of spraying fungicide.

Figure 3.16. Strawberry cv. Albion, leaf spot (fungus disuses) symptom of lower part of leaf.

Figure 3.17. Strawberry cv. Albion, leaf scorch (fungus disuses) symptom on leaf surface.

Figure 3.18. Controlled fungus disease by used TERX 800 (fosetyl aluminum).

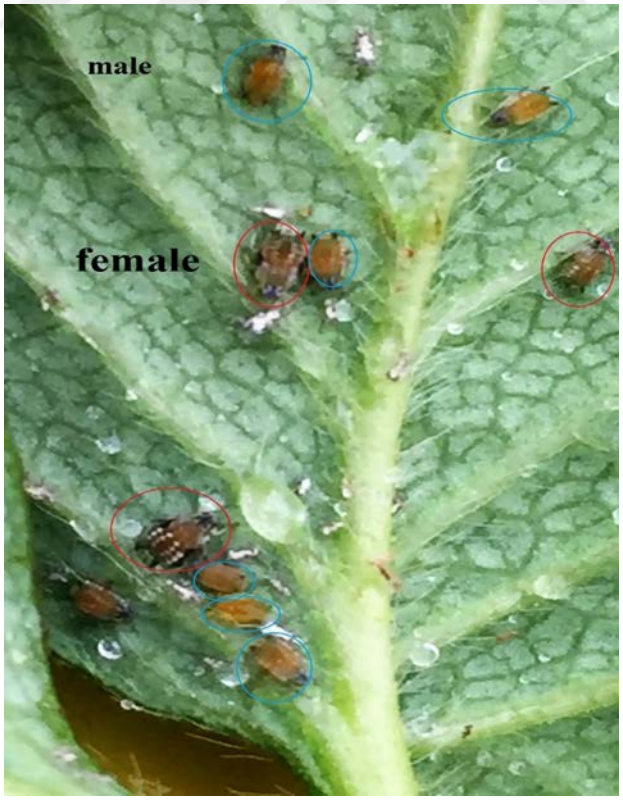

Figure 3.19. Male and female aphid in lower part of laves of Strawberry cv. Albion.

3.2.3.4 . Irrigation

The root system of strawberry is shallow root and it located in 15-20 cm upper part of soil so it need to slow irrigation on the surface of soil, At the beginning of March, we established drip irrigation system and applied irrigation one time per day in morning, after increases temperature from the middle of April we increased the irrigation for two time per day. Because temperature is become more than (35°C) Figure 3.20.

Figure 3.20. Drip irrigation system of my experiment on Strawberry cv. Albion.

3.2.3.5 . Weather: For Kalar weather show the table 3.3.

3.2.4 . Cold Weather:

The frozen my bee causes to damage on the flower in February and March, the strawberry can be live until (-10 °C) (Sønsteby and Heide, 2008). We don't have a more of cold, minimum temperature is (-3 °C), but for more growth, the best temperate for growth and flowering and fruiting is between 15°C -20°C (Palencia et al., 2013). Established the plastic tunnel with a simple tool that we can do it in every farming Figure 3.21.

Figure 3.21. Established the plastic tunnel with a simple tool for better growth.

3.2.4.1.1 . Hot weather:

In a many research show that the high temperate between 25°C -30°C have a very bad effect on strawberry fresh fruit weight, size and flower formation (Ledesma et al., 2008). In my experiment temperature at the middle of April start to increase, is more than 35°C. The effect of high temperature on strawberry fruit size and weight is clearly show from my experiment at the beginning of May until the last harvest Figure (3.22 and 3.23) and it was effect on the yield per plant and hectare. (Palencia,1985; Pedro et al., 2013).

Figure 3.22. Decreases the weight and size of fruit at 13/5/2017 Strawberry cv. Albion.

Figure 3.23 Fruit weight and size at April.

Table 3.3. Weather of Kalar as Sulaymaniyah /Iraq, at January/2017 to June/2017**.**

Date	average temperature /month	maximum temperature / month	minimum temperature / month	average relative humidity /month	maximum relative humidity /month	minimum relative humidity /month
mm/yy	C	C	C	%	%	%
Jan-17	8.72	20.3	-2.98	88.19	100	0.89
Feb-17	12.62	25.73	0.92	73.59	100	0.9
Mar-17	15.7	28.22	2.47	65.59	100	0.9
Apr-17	21.01	38.4	5.53	9.71	100	0.89
May-17	27.49	41.91	13.66	15.27	100	0.92
Jun-17	33.51	46.95	17.49	21.13	56.45	7.33

3.2.5 . Vegetative growth characteristic:

3.2.5.1 . Single leaves area

We are used three complete expanded leaves from all plant and six plants from all treatment after final harvest to measurement leaves area I used CI-202 portable laser leaves area meter Figure 3.24.

Figure 3.24. CI-202 portable laser leaf area meter, that used for measuring leaf area.

3.2.5.2 . Total leaf area per plant (cm^2): determine by calculated single leaf area x total leaf per plant.

3.2.5.3 . Leave number per plant: we measured the leaves after last harvest, for all plant per experiment unite.

3.2.5.4 . Vegetative fresh weight:

In this case we collect the canopy of five plants was randomly selected from every plant after the final harvest. Putted the plant in polyethylene bags when transferred to the lab for test. After that we measurement the shoot system weight (Taha, 2008).

3.2.5.5 . Vegetative dry weight:

In this case we collect the canopy of five plants was randomly selected from every plant after the final harvest. Putted the plant in polyethylene bags when transferred to the lab for test. After that we putted the shoot system in oven to dried at (70 °C) for 24 h, after that we measurement the dried shoot system weight (Taha, 2008).

3.2.5.6 . Root dry weight:

In this case we collect The root of five plants was randomly selected from every Treatment after the final harvest. Then the roots washed very well with tap water and Putted the plant in polyethylene bags when transferred to the lab for test. After that we putted the root system in oven to dried at (70 °C) for 24 h, after that we measurement the dried root system weight (Taha, 2008).

3.2.5.7 . Chlorophyll (total =chlorophyll A + chlorophyll B) content in plant:

In this case we use Three leaves from every plant under every treatment to define chlorophyll content by ply a chlorophyll measurements machines (Konica Minolta SPAD_502 plus), Figure 3.25. The ratio of ten reading was taken to determine chlorophyll pigments presents in every leaves.

Figure 3.25. When using a chlorophyll measurements device (Konica Minolta SPAD-502 plus).

3.2.5.8 . Strawberry runner properties (daughter plant):

Strawberry propagation is occurring by seed, crown and runner. Propagation by runner or seed is depending of your goal of your work, if you working in nursery you use seed, but if you wont to production or establish the farming you need to use the runner because it was a fast way to production a fruit and it was a commercial way. The strawberry produces a daughter plant (runner) via stolon(runner), both of them is called runner Figure (3.26 and 3.27). at 8/5/2017 let plant to produce runner because temperature is changed to high (≥ 35 ℃) and plant reduce flowering , so we record the stolon and daughter plant after last harvest (Li Hong et al., 2014; Poling, 2012; Kher et al., 2010).

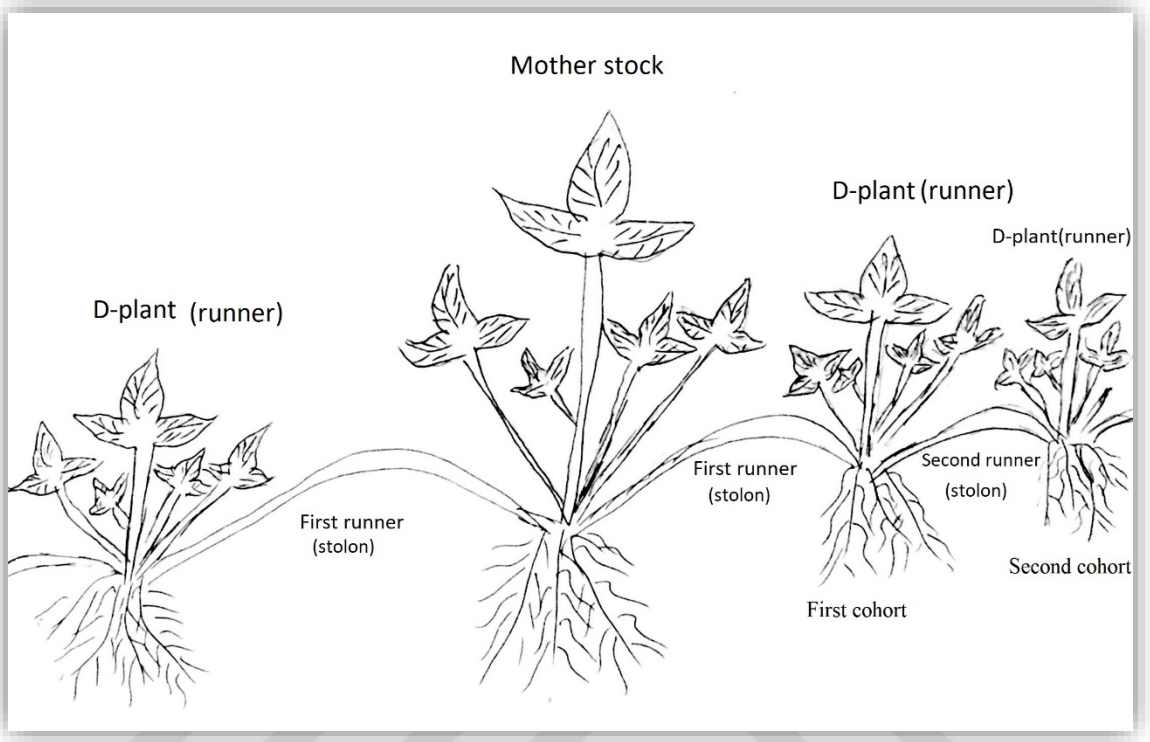

Figure 3.26. Daughter plant, this figure has a four D-plants and five stolons.

3.2.5.9 . Strawberry runner properties (stolon):

The strawberry produces a daughter plant (runner) via stolon(runner), both of them is called runner Figure (3.26 and 3.27). at 8/5/2017 let plant to produce runner because temperature is changed to high (≥ 35 ℃) and plant reduce flowering , so we record the stolon and daughter plant after last harvest (Kher et al., 2010; Poling, 2012; Li Hong et al., 2014)

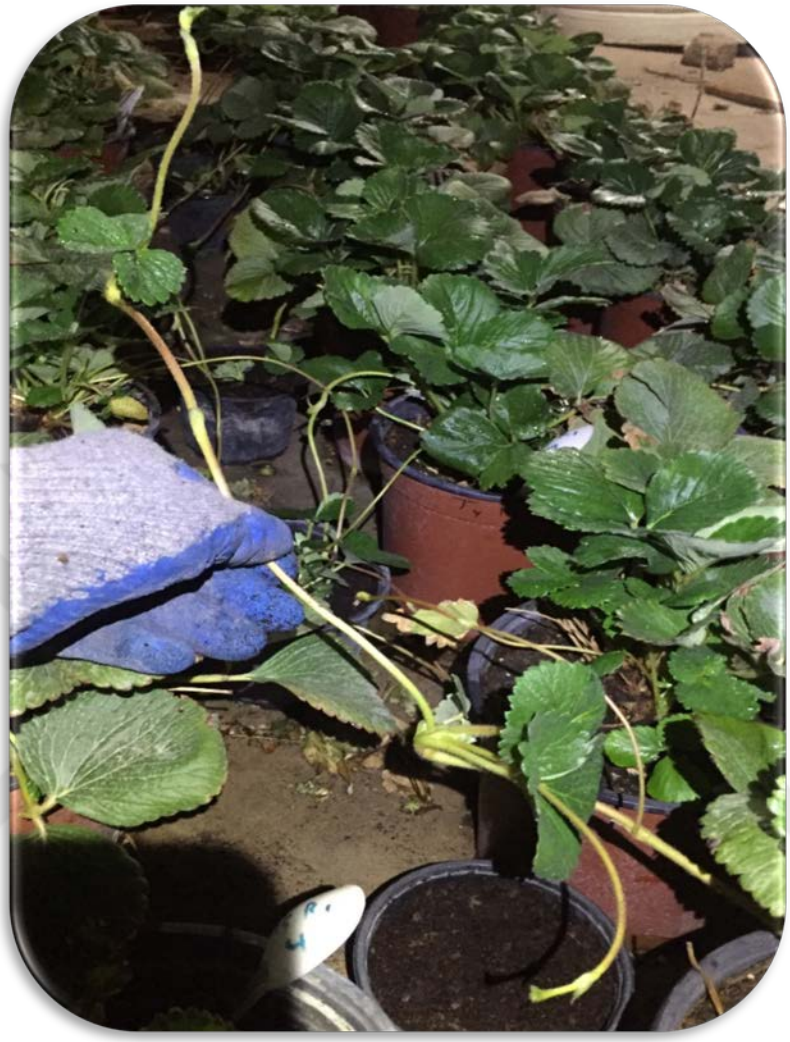

Figure 3.27 In this figure plant have a two D-plant and five stolon Strawberry cv. Albion.

3.2.5.10. Strawberry crown:

We can use a plant with a serval crown for propagation by crown division, the ever bearing strawberry cv. Albion it was a one of this varieties that can use this way for propagation because it produces a many crown per plant Figure 3.28. And the best time for this process is winter because the strawberry cannot produce runner in winter, for this process is be a better use a one year old plant stock or generally not produce fruit more than one season. old plant can be used but not successfully like a younger, (Jahn and Dana,1970).

Figure 3.28 Strawberry cv. Albion white seven crown.

3.2.6 . Flower characteristics

3.2.6.1 . Flowers number per plant

Determine by measurement and calculated all flowers producing per every plant.

3.2.6.2 . Flower setting percentage

Determine by measurement and calculated the ratio of fertilized flowers during start the ovaries swell.

$$\text{Flower setting percentage} = \frac{\text{Number of total fruits}}{\text{Number of total flowers}} \times 100$$

3.2.7 . Fruit characteristics

3.2.7.1 . Number of fruits per plant

We start measurement the number of fruits per plant from the first harvest on March 12/3/2016 to the final harvest on June 12/6 /2016.

3.2.7.2 . Average fruit weight

Determined by calculated according to the following step;

$$\text{Average fruit weight} = \frac{\text{Total fruit weight}}{\text{Total fruit numbers}}$$

3.2.7.3 . Average fruit volume

Determined by used beakers and pot the water on the beakers, deepening fruit on the beakers and measuring the volume of fruit.

$$\text{Average fruit volume} = \frac{\text{Total volume of fruit per plant}}{\text{Total numbers of fruit}}$$

3.2.7.4 . Average total fruit volume:

Determined by calculated according to the following step;

$$\text{Average total fruit volume} = \frac{\text{Total volume of nine plant}}{\text{Nine plant}}$$

3.2.7.5 . Yield per plant (g)

Determined by calculated according to the following step;

$$\text{Plant yield (g)} = \frac{\text{Total weight of fruit}}{\text{Total number of fruit}}$$

3.2.7.6 . Yield per area unit (kg. hectare);

Determined by calculated according to the following steps if the distance between two plant is 30*30 cm^2, is equal to 0.9 m^2.

$$\text{Number of plant per hectare} = \frac{10000\ m^2}{0.9}$$

$$\text{Total yield per Hectare } (kg.h^{-1}) = \frac{\text{Yield per plant} * \text{number of plant per hectare}}{1000}$$

3.2.8 . Fruits qualitative properties

3.2.8.1 . Fruit total soluble solid percentage (TSS %)

Using the juice of four fruit in four data per plant and using Table Refractometer (Atago Automatic Digital Refractometer, RX-5000) Figure (3.29), the fruit was harvested through programmed level of the TSS (8 %) according to (Spayd and Morris, 1981).

Figure 3.29. Table Refractometer (Atago Automatic Digital Refractometer, RX-5000).

3.2.8.2 . Fruit total acidity (TA %)

$$\textbf{TA\%} = \frac{\text{Vol. of titrate} * \text{N(NAOH) of titrate} * \text{Eqv.Wt. of citric acid}}{\text{Vol.of sample} * 1000} * 100$$

Normality (N)= 0.01

Eqv.Wt. of citric acid = 64 (Onopiuk *et al.*,2017)

Vol.of sample = after dilution is 10

It was determined by using titration with NAOH (0.01 N) for more detectable results and phenolphthalein index, according to (A.O.A.C., 1995; Shrestha et al.,2012) and Using the juice of four fruit in four data per plant, take one ml of juice than diluting in nine ml of distal water than propped two or three drop of phenolphthalein indicator and dropped NAOH (0.01 N) and witted to change the color to became a purple color, Figure (3.30).

1

2

3

4

Figure 3.30. Four step for determined total acidity.

3.2.8.3 . TSS/TA ratio (ripening index): calculated by the following equation;

$$\text{TSS/TA ratio} = \frac{\text{Total soluble solid percentage (T.S.S \%)}}{\text{Total acidity (TA \%)}}$$

3.2.9 . Leaf nutrient element analysis:

There was twelve leaf sample with two replication first replecation is after appled seaweed in flowering stage and secand replecation is after appled seaweed after first harvest for analysis with ICP-MS. For this purpose samples 60 ^{o}C 48 hours in the drying oven dried. Examples in the mood was thoroughly it is ground. It was recorded from the sample tartılarak 1.0 g precision weighing. Sample dry Kjeldahl tube. Nitric acid respectively on 21 mL, 3 mL of concentrated sulfuric acid and 3 mL concentrated perchloric acid is added. Burn unit by connecting the Brown smoke output in January that pulls 40% energy until it was used with. 100% energy until then tried with white smoke. Determination of nitrogen in order to dried and milled prototypes 2 hours 60 °C drying oven in heated. And has been applied to the device. The equipment used: ICP-MS; Element used in determining concentrations. Thermo Scientific requiring Q ICP-MS device .

4 . RESULTS AND DISCUSSION

4.1 . Vegetative Growth Character

4.1.1 . Single leave area per plant (cm^2):

Table (4.1) show the effect of seaweed (Alga 600) on single leaf area, that there is increasing of single leaf area per plant compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of single leaf area (127.88 cm^2), These results due seaweed (Alga 600) contains more vitamins, amino acids and some trace elements. However, the past studies have been show that seaweed extracts indirectly or directly, prefer to the physiological performance of the plants, and These results due seaweed (Alga 600) contains of auxin and cytokines thus effected to cell division and elongation of cell, (Abou El-Yazied et al.,2012; El-Miniawy et al.,2014; Saif Eldeen et al.,2014).

Table 4.1. Effect of fertigation of seaweed (Alga 600) with different concentration on single leaf area(cm^2) of strawberry cv. Albion

Name	Single leaf area per plant (cm^2) ^{NS}
T1(control)	102.87
T2 (2 $g.L^{-1}$)	106.52
T3 (4 $g.L^{-1}$)	116.35
T4 (8 $g.L^{-1}$)	127.88

NS: not significantly different

4.1.2 . Total leaf area per plant (cm^2):

Data in Table (4.2) show the effect of seaweed (Alga 600) on total leaf area per plant, that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of Total leaf area per plant is (1464.44 cm^2) and lowest value recorded by control treatment (1038.21 cm^2), These results occur because seaweed effected to increasing the single leaf area, and These results due seaweed (Alga 600) contains more vitamins, amino acids and some trace

elements. However, the past studies have been show that seaweed extracts indirectly or directly, prefer to the physiological performance of the plants, and These results due seaweed (Alga 600) contains of auxin and cytokines thus effected to cell division and elongation of cell (Abou El-Yazied et al.,2012; El-Miniawy et al.,2014 and Saif Eldeen et al.,2014).

Table 4.2. Effect of fertigation of seaweed (Alga 600) with different concentration on total leaf area per plant of strawberry cv. Albion.

Name	Total leaf area (cm^2) ^{NS}
T1(control)	1038.21
T2 (2 $g.L^{-1}$)	1088.56
T3 (4 $g.L^{-1}$)	1167.29
T4 (8 $g.L^{-1}$)	1464.44

NS: not significantly different.

4.1.3 . Leave number per plant:

The results showed in the Table (4.3) clearly revealed that, fertigation levels and their combinations clearly affected to the number of leaves but it was not significant. The highest value recorded by fertigation with seaweed (Alga 600) in 8 $g.L^{-1}$(11.33 unit**),** the lowest value recorded by control treatment (9.48 unit), These results may be due seaweed (Alga 600) contains more vitamins, amino acids and some trace elements. However, the past studies have been show that seaweed extracts indirectly or directly, prefer to the physiological performance of the plants, and These results due seaweed (Alga 600) contains of auxin and cytokines thus effected to cell division and elongation of cell (Abou El-Yazied et al.,2012; El-Miniawy et al.,2014 and Saif Eldeen et al.,2014).

Table 4.3. Effect of fertigation of seaweed (Alga 600) with different concentration on leaves number per plant of strawberry cv. Albion.

Name	Number of leaf per plant ^{NS}
T1(control)	9.48
T2 (2 g.L^{-1})	9.74
T3 (4 g.L^{-1})	10.59
T4 (8 g.L^{-1})	11.33

NS: not significantly different.

4.1.4 . Vegetative fresh weight (g):

Date in Table (4.4) show that the effect of seaweed (Alga 600) on Vegetative fresh weight, that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 g.L^{-1}give the maximum value of Vegetative fresh weight (65.95 g) and lowest value recorded by control treatment (53.02 g).these result happened because seaweed effected to increasing of single leaf area and leaf number per plant in this experiment, (El-Miniawy et al.,2014; Saif Eldeen, et al.,2014).

Table 4.4. Effect of fertigation of seaweed (Alga 600) with different concentration on vegetative fresh weight of strawberry cv. Albion.

Name	Vegetative fresh weight (g) ^{NS}
T1(control)	53.02
T2 (2 g.L^{-1})	58.12
T3 (4 g.L^{-1})	62.23
T4 (8 g.L^{-1})	65.95

NS: not significantly different.

4.1.5 . Vegetative dry weight (g):

Date in Table (4.5) clearly show the effect of seaweed (Alga 600) on Vegetative dray weight, that there is increasing compare with control treatment, and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of Vegetative dray weight (23.96 g) and lowest value recorded by control treatment (17.74 g), these result happened because seaweed effected to increasing of single leaf area, leaf number per plant and vegetative fresh weight in this experiment and These results due to seaweed (Alga 600) contains more vitamins, amino acids and some trace elements. However, the past studies have been show that seaweed extracts indirectly or directly, prefer to the physiological performance of the plants (Abou El-Yazied et al.2012; El-Miniawy et al.2014 and Saif Eldeen et al.2014).

Table 4.5. Effect of fertigation of seaweed (Alga 600) with different concentration on Vegetative dray weight of strawberry cv. Albion.

Name	Vegetative dry weight (g) ^{NS}
T1(control)	17.74
T2 (2 $g.L^{-1}$)	20.50
T3 (4 $g.L^{-1}$)	21.87
T4 (8 $g.L^{-1}$)	23.96

NS: not significantly different.

4.1.6 . Root dry weight (g):

Date in Table (4.6) show that the effect of seaweed (Alga 600) on Root dry weight, that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of Root dry weight (12.31 g) and lowest value recorded by control treatment (8.36 g), These results due seaweed (Alga 600) contains more vitamins, amino acids and some trace elements. However, these results due to seaweed (Alga 600) contains of cytokines that effected to cell division and elongation of root system, this results are harmony with that information by (Abdel-Mawgoud et al., 2010; Shehata et al., 2011 And Abou El-Yazied et al., 2012).

Table 4.6. Effect of fertigation of seaweed (Alga 600) with different concentration on Root dray weight of strawberry cv. Albion.

Name	Root dry weight (g) ^{NS}
T1(control)	8.36
T2 (2 g.L^{-1})	8.62
T3 (4 g.L^{-1})	11.96
T4 (8 g.L^{-1})	12.31

NS: not significantly different.

4.1.7 . Chlorophyll (Total =Chlorophyll A + Chlorophyll B) content in plant:

Date in Table (4.7) show that the effect of seaweed (Alga 600) on Total Chlorophyll, that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 g.L^{-1}give the maximum value of Total Chlorophyll content in the leaf (41.09 unit) and lowest value recorded by control treatment (38.41 unit),this results clear show the amino acid play a good action in protein syntheses the resulting of that is higher amount of photosynthetic pigment which increasing the total chlorophyll in leaves , this results are harmony with those information by (Schwab and Raab, 2004; Thirumaran et al.,2009; Shehata et al.,2011; El-Miniawy et al.,2014 and Mohamed, 2015).

Table 4.7. Effect of fertigation of seaweed (Alga 600) with different concentration on total chlorophyll in leaves of strawberry cv. Albion.

Name	Total chlorophyll in leaf ^{NS}
T1(control)	38.41
T2 (2 g.L^{-1})	38.81
T3 (4 g.L^{-1})	39.72
T4 (8 g.L^{-1})	41.09

NS: not significantly different.

4.1.8 . Strawberry runner properties (number of daughter plant and Number of Stolon):

Date in Table (4.8) show that the effect of seaweed (Alga 600) on Number Daughter Plant and number of stolon, that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 g.L^{-1}give the maximum value of Number Daughter Plant (4.55 unit) and for number of stolon (7.29 unit) and lowest value recorded by control treatment for daughter plant (3.44 unit) and for number of stolon is (5.85 unit),this results clear show the physiological and biological activity of seaweed extract which content to big amount of auxin and cytokinins thus effected to cell division on the plant, and it may by also effected by GA_3 which caused to increasing the number of runner ,length of the cell and elongation of internodes. this results are harmony with that information by (Hytönen et al.2009; Ragab et al.,2010; Abo Sedera et al. ,2014 and Mohamed, 2015).

Table 4.8. Effect of fertigation of seaweed (Alga 600) with different concentration on number of daughter plant and number of stolon of strawberry cv. Albion.

Name	Number of runner (daughter plant) ^{NS}	Number of stolon ^{NS}
T1(control)	3.44	5.85
T2 (2 g.L^{-1})	3.71	6.66
T3 (4 g.L^{-1})	3.70	6.70
T4 (8 g.L^{-1})	4.55	7.29

NS: not significantly different.

4.1.9 . Strawberry number of crown:

Date in Table (4.9) show that the effect of seaweed (Alga 600) on number of crown, that there is a significant increasing compare with control treatment, and it show the fertigation of seaweed (Alga 600) in 4gm/L and 8 g.L^{-1}give the maximum value of number of crown (T3=3.64 unit) and (T4=3.5 unit) and lowest value recorded by control treatment (2.75 unit). this results due to physiological and biological activity of seaweed extract which content to big amount of auxin and cytokinins thus effected to cell division on the plant. this results are harmony with that information by (Khalid et al.,2013 and Mohamed, 2015).

Table 4.9. Effect of fertigation of seaweed (Alga 600) with different concentration on number of crown of strawberry cv. Albion.

Name	Number of crown**
T1(control)	2.75 b
T2 (2 g.L^{-1})	2.719 b
T3 (4 g.L^{-1})	3.64 a
T4 (8 g.L^{-1})	3.50 a

**: $p<0.01$, significant at 0,01 level.

4.2 . Strawberry Flower Characterize

4.2.1 . Number of flowers per plant:

Date in Table (4.10) clearly show the significant effect of seaweed (Alga 600) on Number of flowers, that there is significant increasing of (T4 21.77 unit and T3 21.59 unit) compare with control treatment (T1 16.55 unit), and it show the fertigation of seaweed (Alga 600) in 4gm/L and 8 $g.L^{-1}$give the maximum value of Number of flowers per plant (T4=21.77 unit and T3=21.59 unit) and lowest value recorded by control treatment (T1=16.55 unit)

Table 4.10. Effect of fertigation of seaweed (Alga 600) with different concentration on number of flower of strawberry cv. Albion.

Name	Number of flower*
T1(control)	16.55 b
T2 (2 $g.L^{-1}$)	17.70 ab
T3 (4 $g.L^{-1}$)	21.59 a
T4 (8 $g.L^{-1}$)	21.77 a

*: $p<0.05$, significant at 0,05 level.

4.2.2 . Fruit Setting percentage:

Date in Table (4.11) clearly show the effect of seaweed (Alga 600) on Setting percentage, that there is not significant effect but increasing (T4 8 $g.L^{-1}$) compare with control treatment, and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$ give the maximum value of Setting percentage (T4=80%) and lowest value recorded by control treatment (T1=70%).

Table 4.11. Effect of fertigation of seaweed (Alga 600) with different concentration on Setting percentage of strawberry cv. Albion.

Name	Fruit Setting percentage ^{NS}
T1(control)	70%
T2 (2 $g.L^{-1}$)	74%
T3 (4 $g.L^{-1}$)	78%
T4 (8 $g.L^{-1}$)	80%

NS: not significantly different.

4.3 . Fruit Characterize

4.3.1 Number of fruits per plant:

Date in Table (4.12) clearly show the significant effect of seaweed (Alga 600) on Number of fruits per plant, that there is significant increasing of (T4 and T3) compare with control treatment (T1), and it show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of Number of fruits per plant (T4=17.70 unit) and lowest value recorded by control treatment (T1=11.81 unit). this results due to increasing the vegetative characteristic or number of crown per plant.

Table 4.12. Effect of fertigation of seaweed (Alga 600) with different concentration on Number of fruits per plant of strawberry cv. Albion.

Name	Number of fruits per plant**
T1(control)	11.81 b
T2 (2 $g.L^{-1}$)	13.40 ab
T3 (4 $g.L^{-1}$)	17.22 a
T4 (8 $g.L^{-1}$)	17.70 a

**: $p<0.01$, significant at 0,01 level.

4.3.2 . Average weight of fruit (g):

Date in Table (4.13) clearly show the effect of seaweed (Alga 600) on Average weight of fruit (g), that there is not significant but increasing of (T4) compare with (T3) and (T2), and it show the fertigation of seaweed (Alga 600) in and 8 $g.L^{-1}$give the maximum value of Average weight of fruit (g) (T4=16.85 g) and lowest value recorded by control treatment (T3=14.65 g). this results due to that the seaweed extract improves some vegetative characteristics. it also stimulates production quality and quantity through the enhancement of photosynthetic process. accordingly, Abdulraheem (2009) has affirmed that seaweed application leads to the improvement in the development of fruit diameter, strength and length in addition to better rate of fruit production. This increasing due to increasing the vegetative characteristic or number of crown.

Table 4.13. Effect of fertigation of seaweed (Alga 600) with different concentration on Average weight of fruit (g) of strawberry cv. Albion.

Name	Average weight of fruit (g)^{NS}
T1(control)	15.80
T2 (2 $g.L^{-1}$)	15.11
T3 (4 $g.L^{-1}$)	14.65
T4 (8 $g.L^{-1}$)	16.85

NS: not significantly different.

4.3.3 . Volume of fruit (ml^3) and Total volume of fruit per plant (ml^3):

Date in Table (4.14) clearly show the effect of seaweed (Alga 600) on Average volume of fruit (ml^3) that there is not significant effect but increasing (T4) compare with control treatment (T1) and (T2), and we can show the fertigation of seaweed (Alga 600) in 8 $g.L^{-1}$give the maximum value of Average volume of fruit (ml^3) (T4=18.88 ml^3) and Total volume of fruit (ml^3) (T4=329.37 ml^3) and lowest value recorded by control treatment. this results due to that seaweed application leads to the improvement in the development of fruit

diameter, strength and length in addition to better rate of fruit production (Abdulraheem, 2009).

Table 4.14. Effect of fertigation of seaweed (Alga 600) with different concentration on Average volume of fruit (ml^3) and Total volume of fruit (ml^3) of strawberry cv. Albion.

Name	Average volume of fruit (ml^3)^{ns}	Total volume of fruit (ml^3)*
T1(control)	17.50	211.74 b
T2 (2 $g.L^{-1}$)	16.89	228.14 b
T3 (4 $g.L^{-1}$)	16.60	285.92 ab
T4 (8 $g.L^{-1}$)	18.88	329.37 a

NS: not significantly different, *: $p<0.05$, significant at 0,05 level.

4.3.4 . Plant yield (g) and Yield per area unit (kg/hectare):

Date in Table (4.15) clearly show the significant effect of seaweed (Alga 600) on Yield per plant (g) and per hectare (kg/hectare), that there is significant increasing of (T4) compare with control treatment (T1) and (T2), and it show the fertigation of seaweed (Alga 600) in and 8 $g.L^{-1}$give the maximum value of Yield per plant(g) (T4=295.03 g) and per hectare (T4=3278.18 kg/h^{-1}) and lowest value recorded by control treatment (T1).this results due to that the seaweed extract improves some vegetative characteristics. it also stimulates production quality and quantity through the enhancement of photosynthetic process. accordingly, (Abdulraheem, 2009) has affirmed that seaweed application leads to the improvement in the development of fruit diameter, strength and length in addition to better rate of fruit production. This increasing due to increasing the vegetative characteristic or number of crown.

Table 4.15. Effect of fertigation of seaweed (Alga 600) with different concentration on Yield per plant (g) and Yield per hectare (kg/hectare) of strawberry cv. Albion.

Name	Yield per plant (g) *	Yield per hectare (kg/hectare)*
T1(control)	191.70 b	2130.04 b
T2 (2 g.L^{-1})	204.11 b	2267.90 b
T3 (4 g.L^{-1})	254.11 ab	2823.45 ab
T4 (8 g.L^{-1})	295.03 a	3278.18 a

*: $p<0.05$, significant at 0,05 level.

4.4 . Fruits Qualitative Properties

4.4.1 . Total soluble solid (TSS):

Date in Table (4.16) show that the effect of seaweed (Alga 600) on Total soluble solid (TSS), that there is increasing compare with control treatment but it was not significant, and it show the fertigation of seaweed (Alga 600) in 8 g.L^{-1}give the maximum value of Total soluble solid (TSS) (7.46 unit) and lowest value recorded by control treatment (6.85 unit). this results are harmony with that information by (El Moniem et al.,2008; Taha, 2008).

Table 4.16. Effect of fertigation of seaweed (Alga 600) with different concentration on Total soluble solid (TSS) of strawberry cv. Albion.

Name	Total soluble solid (TSS)^{NS}
T1(control)	6.85
T2 (2 g.L^{-1})	7.39
T3 (4 g.L^{-1})	7.05
T4 (8 g.L^{-1})	7.46

NS: not significantly different.

4.4.2 . Total acidity (TA)

Date in Table (20) show that the effect of seaweed (Alga 600) on Total acidity (TA), there are significant differences among the treatment. increasing of seaweed extract (Alga 600) decreases the TA, control treatment has significant deference with (T2) and higher than T4 but it is not significant, and it show the maximum value in control treatment and lowest value recorded by fertigation of seaweed (Alga 600) in 2g. L^{-1}, it is happened because when (TSS) increasing the (TA) is decreasing.

Table 4.17. Effect of fertigation of seaweed (Alga 600) with different concentration on Total acidity (TA) of strawberry cv. Albion.

Name	Total acidity* (TA)
T1(control)	0.88 a
T2 (2 g.L^{-1})	0.69 b
T3 (4 g.L^{-1})	0.74 ab
T4 (8 g.L^{-1})	0.80 ab

*: $p<0.05$, significant at 0,05 level.

4.4.3 . TSS/TA ratio (ripening index):

Date in Table (4.18) show that, the effect of seaweed (Alga 600) on TSS/TA ratio in (T4 and T2) significantly increasing compare with control treatment, and it show the fertigation of seaweed (Alga 600) in 8 g.L^{-1}give the maximum value of TSS/TA ratio (13.35 unit) and lowest value recorded by control treatment (8.29 unit). this results are harmony with that information by (El Moniem et al.,2008; Taha, 2008).

Table 4.18. Effect of fertigation of seaweed (Alga 600) with different concentration on TSS/TA ratio of strawberry cv. Albion.

Name	TSS/TA ratio**
T1(control)	8.29 b
T2 (2 g.L^{-1})	13.11 a
T3 (4 g.L^{-1})	11.81 ab
T4 (8 g.L^{-1})	13.35 a

**: p<0.01, significant at 0,01 level.

4.5 .Leaf Nutrient Element Analysis:

Plant nutrient is divided to two part it was macro nutrient and micro nutrients. Macro nutrient consist of potassium (K), calcium (Ca), magnesium (Mg), phosphor (P) and nitrogen (N). They are the essential requirement for plant and we need to feeling of that. It was very important for fertilization because enhance the activity of plant function.

Micronutrients is like iron(Fe), copper(Cu), chlorine(Cl), boron(Bo), manganese (Mn) and zinc(Zn). It is non-essential for plant and plant used in very small amounts, but it don't mean plant don't need micronutrient, actually it is important to plant profitable crop production and development like essential nutrient.

Table 4.19. Effect of fertigation of seaweed (Alga 600) with different concentration on two stage of strawberry cv. Albion statically compere each other.

Treatment	N ** (ppm)	P** (ppm)	K** (ppm)	Mg** (ppm)	Ca** (ppm)	Mn** (ppm)	Fe** (ppm)	Cu NS (ppm)	Zn NS (ppm)
In flowering stage	3,73±0.09 a	5657,78±182.61 a	20155,3±782.19 a	3380,43±212.56 b	490,88±35.10 b	131,30±8.19 b	267,62±13.02 b	3,17±0.14	31,90±1.65
After first harvest	2,31±0.09 b	2525,63±182.61 b	15505,2±782.19 b	6487,06±212.56 a	1281,56±35.10 a	242,09±8.19 a	484,77±13.02 a	3,22±0.14	29.70±1.65

**: p<0.01, significant at 0,01 level; NS: not significantly different.

4.5.1 . Nitrogen (N)

Date in figure (4.1) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on nitrogen in leaf of strawberry cv. Albion is not significant compere with control but some increasing happened in (T3) compere with (T1, T2, T4), maximum value in (T3) in flowering stage and minimum value in (T4) in flowering stage, and in second stage maximum value in control treatment and minimum value in (T2). If the Comparation is between this two stage, we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in first stage compere with second stage. The highest nitrogen value is recorded in flowering stage (3,73±0.09) and the lowed value is recorded in after first harvest (2,31±0.09), and this deferent happened because the consumption of plant for nitrogen in fruiting stage is to more (Rathore, S.S. et al.,2009), seaweed which is containing minerals, are not able to supply all the essential nutrients in the quantities required by plants (Schmidt et al.,2003), but may enhance root growth of plant. This result agrees with (Shehata, S.M et al.,2011).

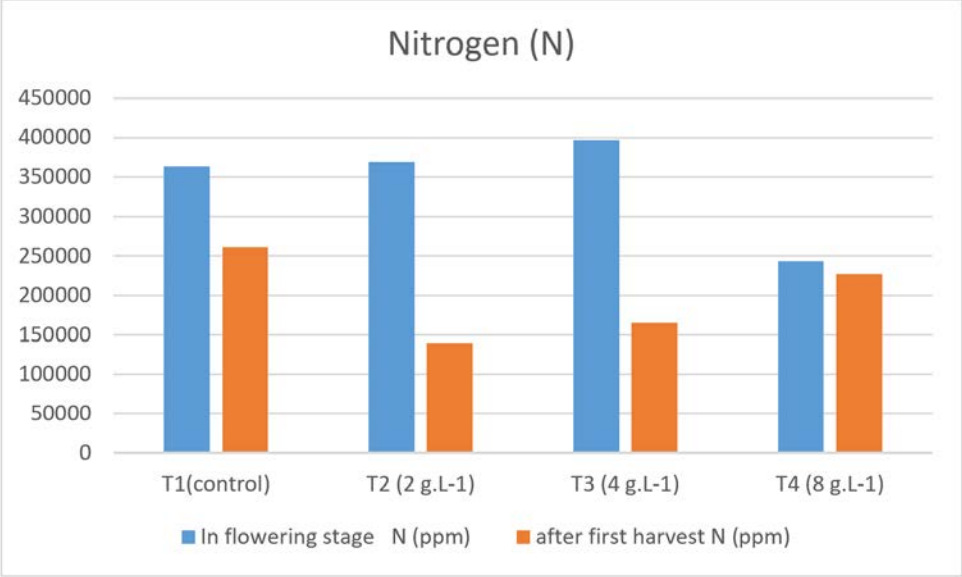

Figure 4.1. Nitrogen content (ppm) in leaf of strawberry cv Albion.

4.5.2 . Phosphor (P)

Date in figure (4.2) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on phosphor in leaf of strawberry cv. Albion is not significant compere with control treatment but maximum value in (T4) in flowering stage and minimum value in (T3) in flowering stage, and in second stage the maximum value in in (T1) and the minimum value in (T4), and if the comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in first stage compere with second stage. The highest Phosphor value is recorded in flowering stage (5657,78±182.61) and the lowed value is recorded in after first harvest (2525,63±182.61). Generally phosphor has a high level content in the leaf and plant need a large amount of phosphor for plant production (Margarida A et al.,2014). Phosphor is a several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next (D.G. Blevins, 1999).

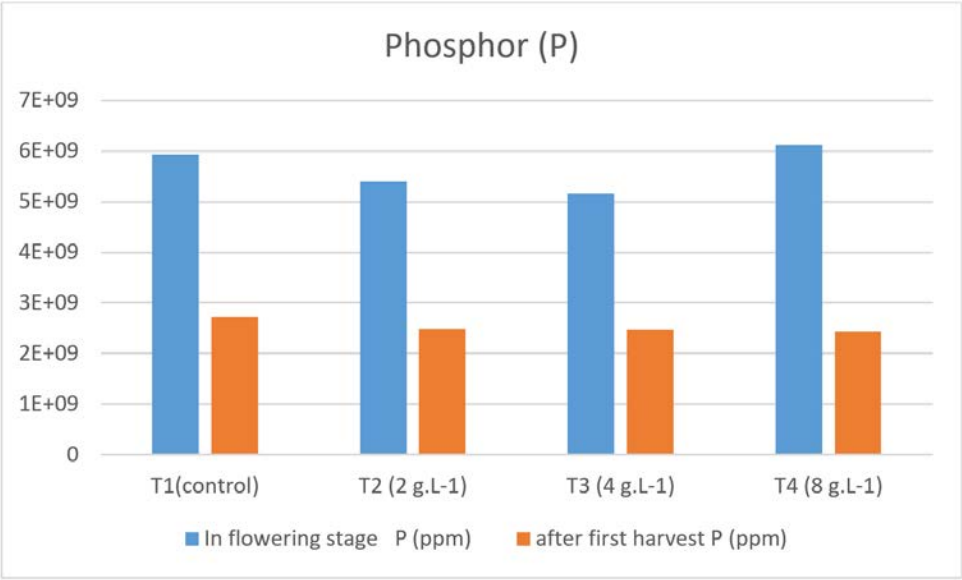

Figure 4.2. Phosphor content (ppm) in leaf of strawberry cv Albion.

4.5.3 . Potassium (K)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on potassium in leaf of strawberry cv. Albion is not significant compere with control treatment but maximum value in (T4) in flowering stage and minimum value in (T3) in flowering stage, and in second stage the maximum value in (T3) and the minimum value in (T4), and if the comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in first stage compere with second stage. The highest potassium value is recorded in flowering stage (20155,3±782.19) and the lowed value is recorded in after first harvest (15505,2±782.19) (Dhriti Battacharyya et al.,2015), Potassium is one of the major nutrient element for plant and it work to activate the meristematic tissue growth, water case and photosynthesis activity (Mengel and Kirkby, 1987).

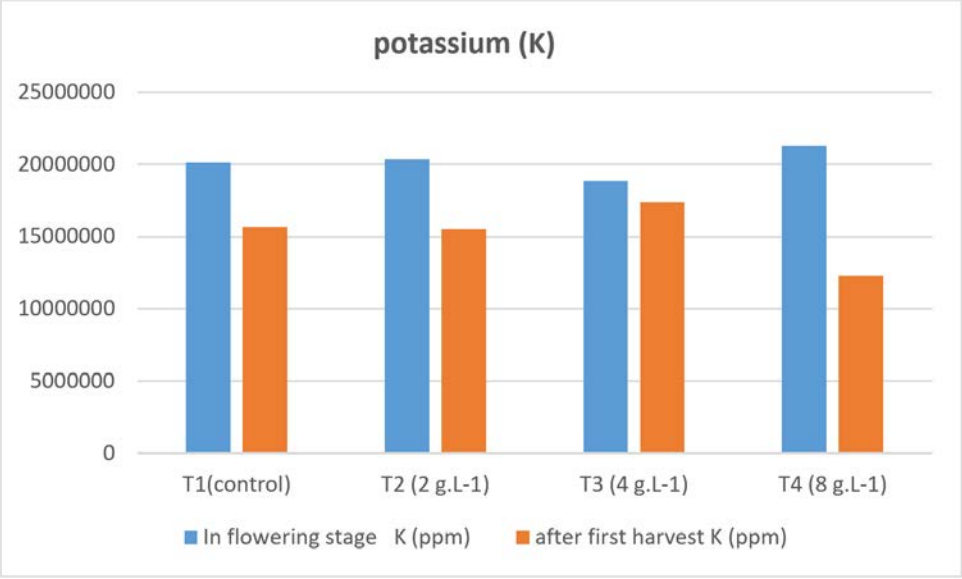

Figure 4.3. Potassium content (ppm) in leaf of strawberry cv Albion.

4.5.4 . Magnesium (Mg)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Magnesium in leaf of strawberry cv. Albion is not significant compere with control treatment but some increasing happened in (T4 and T2) compere with control, maximum value in (T4) in flowering stage and minimum value in control in flowering stage, and in second stage maximum value in (T3) and minimum value in (T4).If the Comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in second stage compere with first stage. The highest Magnesium value is recorded in after first harvest (6487,06±212.56) and the lowed value is recorded in flowering stage (3380,43±212.56). magnesium is key nutrient of chlorophyll production, improving and mobility of phosphor, activity and component of some plant hormone; influence earliness and uniformity of maturity. In some study show the magnesium caused to increasing of fruit yield because it effects to increase the intensity of photosynthesis (Tavasoli et al.,2010)

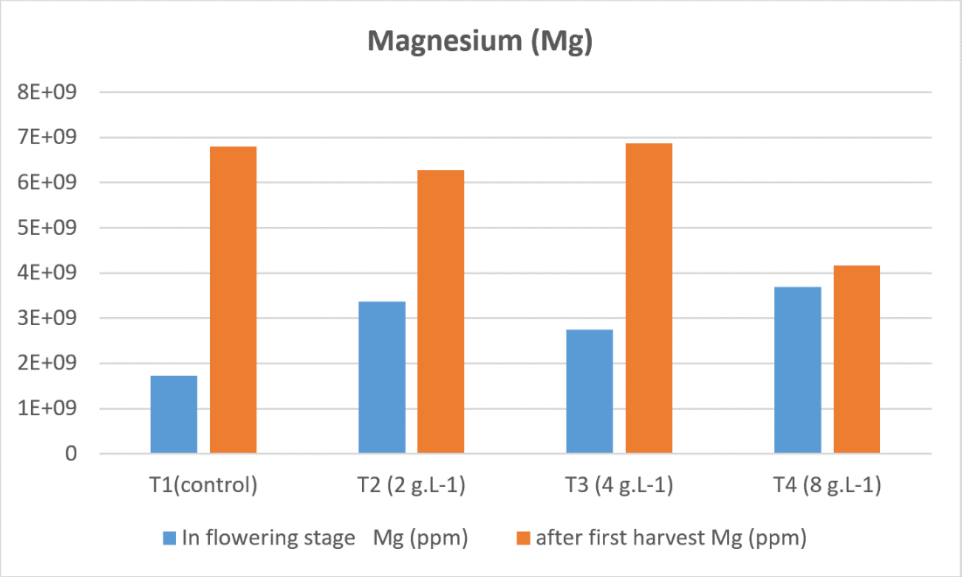

Figure 4.4. Magnesium content (ppm) in leaf of strawberry cv Albion.

4.5.5 . Calcium (Ca)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Calcium in leaf of strawberry cv. Albion is not significant compere with control treatment but some increasing happened in (T4 and T2) compere with control, maximum value in (T4) in flowering stage and minimum value in control in flowering stage, and in second stage maximum value in control treatment and minimum value in (T2).If the Comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in second stage compere with first stage. The highest Calcium value is recorded in after first harvest (1281,56±35.10) and the lowed value is recorded in flowering stage (490,88±35.10).

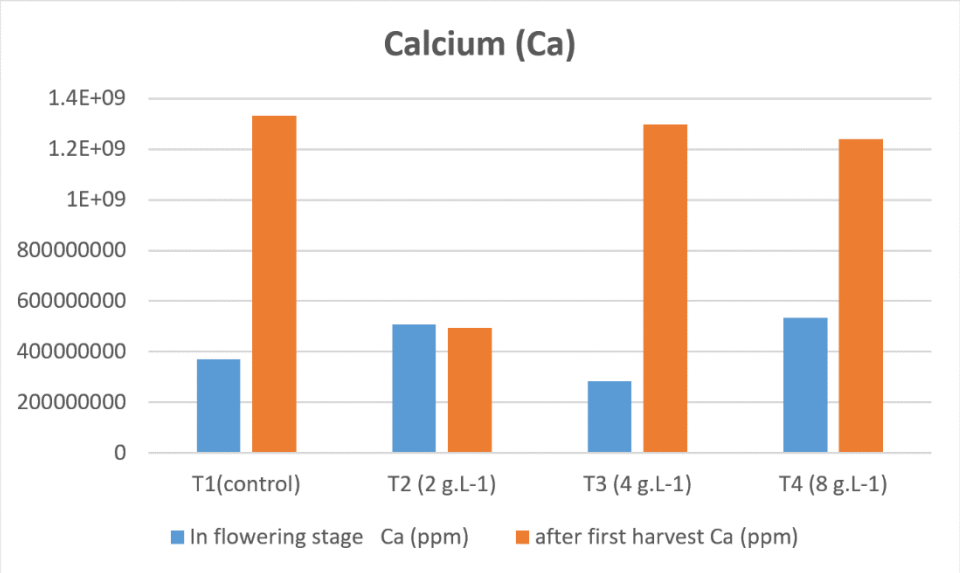

Figure 4.5. Calcium content (ppm) in leaf of strawberry cv Albion.

4.5.6 . Manganese (Mn)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Manganese in leaf of strawberry cv. Albion is significant increased statically in $p<0.05$, compere with control treatment and maximum value in (T4) and minimum value in (T1) in flowering stage, but in fruiting stage the increasing happened but not significant so maximum value in (T4) and minimum value in (T1) in fruiting stage. If the Comparation is between this two stage, we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in second stage compere with first stage. The highest Manganese value is recorded in after first harvest (242,09±8.19) and the lowed value is recorded in flowering stage (131,30±8.19). This increase happened because seaweed is good source of micronutrient for plant, fertigation by seaweed is uptake by root system and harmful to increase the vegetative growth, yield and pest resistance if applied as liquid sprays (Reeta Kumari et al.,2011), seaweed enhance the growth of root system and it effect to more uptake of nutrient (Crouch et al.,1990).

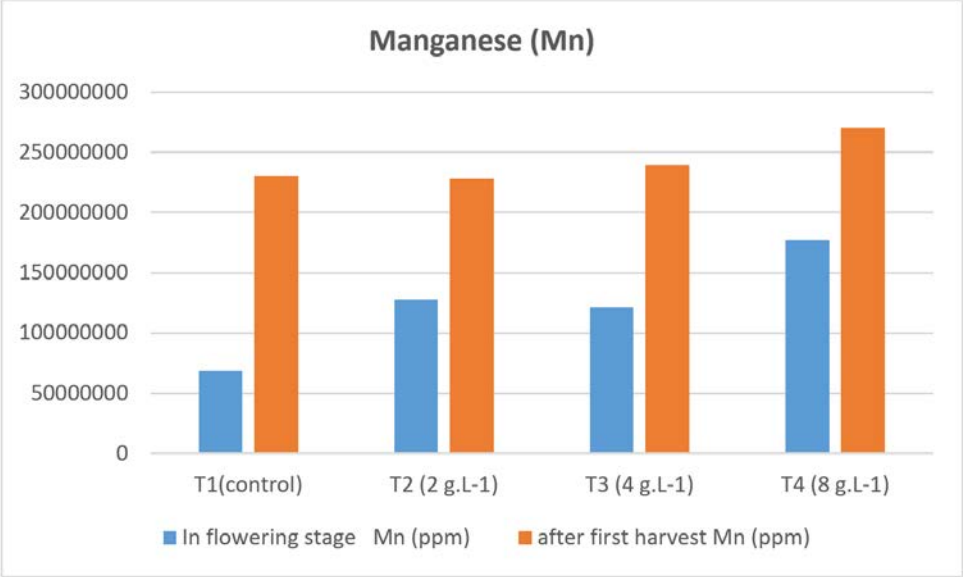

Figure 4.6. Manganese content (ppm) in leaf of strawberry cv Albion.

4.5.7 . Iron (Fe)

Date in figure (4.7) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Iron in leaf of strawberry cv. Albion is not significant compere with control treatment but some increasing happened in (T1 and T4) compere with (T2 and T3), maximum value in (T1) in flowering stage and minimum value in (T2) in flowering stage, and in second stage maximum value in (T4) and minimum value in control. if the Comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in second stage compere with first stage. The highest Iron value is recorded in after first harvest (484,77±13.02) and the lowed value is recorded in flowering stage (267,62±13.02).

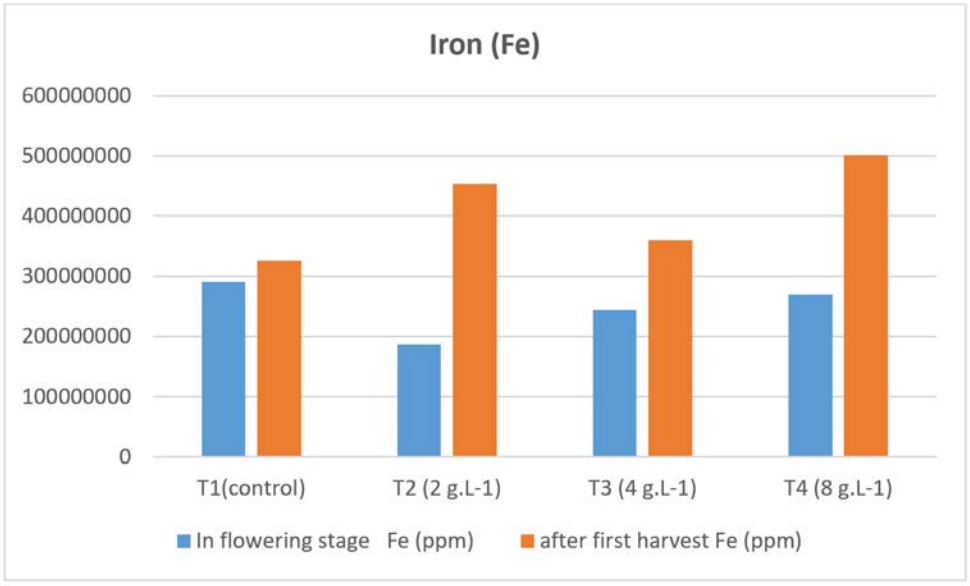

Figure 4.7. Iron content (ppm) in leaf of strawberry cv Albion.

4.5.8 . Copper (Cu)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Copper in leaf of strawberry cv. Albion is not significant compere with control treatment but some increasing happened in (T1) compere with (T2), maximum value in (T1) in flowering stage and minimum value in (T2) in flowering stage, and in second stage maximum value in control treatment and minimum value in (T3). if the Comparation is between this two stage we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in first stage and second stage. The

highest Copper value is recorded in flowering stage (20155,3±782.19) and the lowed value is recorded in after first harvest (15505,2±782.19).

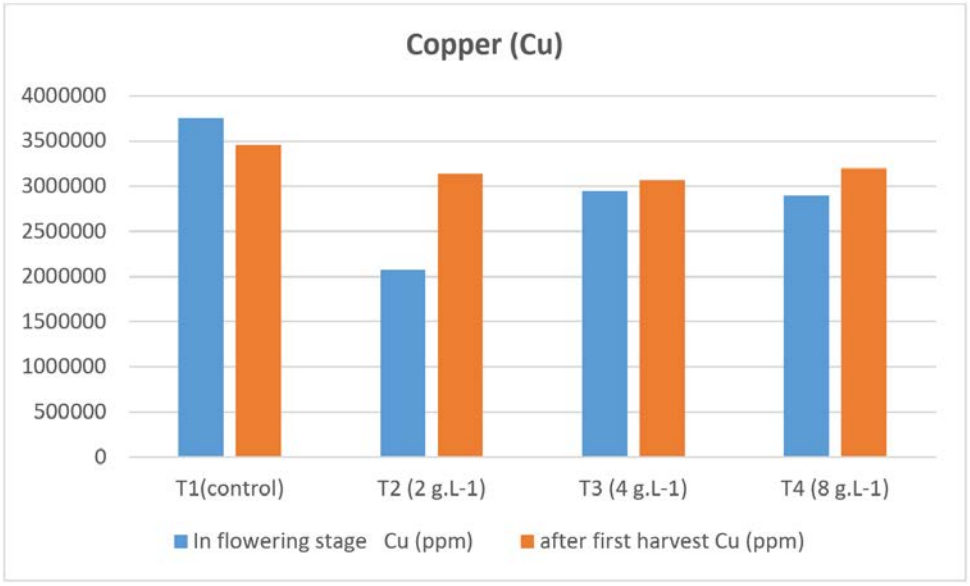

Figure 4.8. Copper content (ppm) in leaf of strawberry cv Albion.

4.5.9 . Zinc (Zn)

Date in figure (4.6) clearly show the effect of fertigation of seaweed (Alga 600) with different concentration on Zinc in leaf of strawberry cv. Albion is not significant compere with control treatment but some increasing happened in (T4, T1 and T2) compere with (T3), maximum value in (T4) in flowering stage and minimum value in (T3) in flowering stage, and in second stage maximum value in (T3) and minimum value in (T2). If the Comparation is between this two stage, we can clearly show in table (4.19) the significant deferent in ($p<0.01$) between the effect of seaweed (Alga 600) in first stage and second stage. The highest Zinc value is recorded in flowering stage (20155,3±782.19) and the lowed value is recorded in after first harvest (15505,2±782.19). In some study show the zinc caused to increasing of fruit yield because it effects to increase the intensity of photosynthesis (Tavasoli et al.,2010).

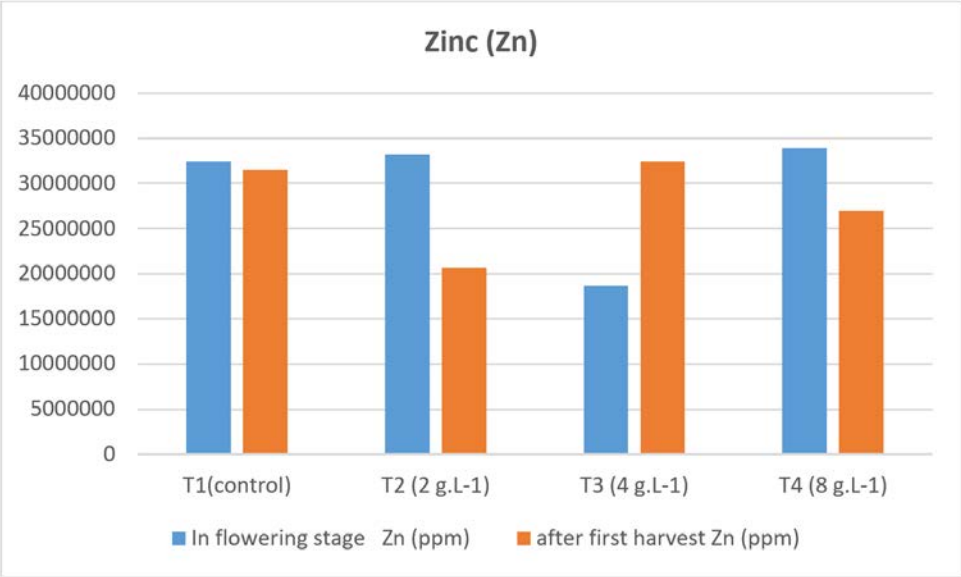

Figure 4.9. Zinc content (ppm) in leaf of strawberry cv Albion.

5 . CONCLUSIONS AND RECOMMENDATION

5.1 . Conclusion

Based on this results on this present study concerning the effect of seaweed (algae 600) on flowering, vegetative growth and fruiting of strawberry cv. Albion, the following conclusion can be drawn.

- The seaweed extract (algae 600) at 2 $g.L^{-1}$ is less effective on strawberry vegetative properties, flowering and yield properties and chemical characteristics of fruit than other treatment.
- The seaweed extract (algae 600) at 4 $g.L^{-1}$ is more effective than 2 $g.L^{-1}$ and it have significant effect on number of the crown, number of flower, number of the fruit at 0.01 level, and total volume of fruit, yield per plant, yield per hectare, TA and TSS/TA ratio at 0.05 level. And generally seaweed extract (algae 600) do not have a significant effect on macro nutrient and micro nutrient in leaf but nitrogen content in leaf record the maximum value at 4 $g.L^{-1}$ after first application; potassium, magnesium and zinc content in leaf recorded the maximum value at 4 $g.L^{-1}$ but after last application.
- The seaweed extract (algae 600) at a higher concentration (8 $g.L^{-1}$) give the more effect to increasing the vegetative growth, flowering and yield characteristics. and it have significant effect on number of the crown, number of flower, number of the fruit at 0.01 level, and total volume of fruit, yield per plant, yield per hectare, TA and TSS/TA ratio and effect on the manganese content in leaf at flowering stage at 0.05 level. Seaweed extract (algae 600) significantly effect to increase the manganese content in the leaf and in the both time of applications, and generally seaweed extract (algae 600) at 8 $g.L^{-1}$ is more effective on the macro and micro nutrient in the leaf because the maximum value of potassium, phosphor, magnesium, calcium, manganese, and zinc is recorded in T4 after first applications and after last applications the maximum value recorded in iron and manganese content in the leaf.

5.2 . Recommendation

Based on the conclusions talk about previously, the flowing points of view can be recommended:

- In Kalar city don't have any strawberry farms and farmers so we need to learning the farmer how to cultivate strawberry and what is the benefit of strawberry.
- Experimentation the effect of deferent growing media especially local media.
- Experimentation the effect of seaweed extract in green house or in the place where covered with sunblock shade, because the sun in this area is to worm and effect to lose the water in side of fruit in reduce the weight and volume and effect the plant by reduce water of all part of plant.
- Experimentation the effect of another seaweed extract, like sea force, cytics, algamix etc.
- Experimentation the time of transplanting, then its important factor affecting the positive of strawberry development in north of Iraq.
- Experimentation foliar application of seaweed algae 600 more than 8 $g.L^{-1}$ to find greatest effects.
- Experimentation the above treatment on other cultivars of strawberry.
- Experimentation the cultivation strawberry in deferent shape like vertical shape on the tube to benefit from small area.

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