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SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Effect of Some Fertilizer Types on Growth, Yield and Quality of Cucumber (*Cucumis sativus* L.) Unde r Cooled Plastic Tunnels Conditions

تأثير بعض أنواع الأسمده علي نموء وإنتاج وجودة الخيار تحت ظروف الأنفاق البلاستيكية المبردة

By

Ahmed Elzebeir Mustafa Mahmoud

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College of Agricultural Studies

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Supervisor Prof. Dr. Ayoub Zeyada Elhag

Department of Horticulture

College of Agricultural Studies

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DECLARATION

I declare that this dissertation, prepared for the Masters of Science degree in Horticulture Sciences, which I submitted to the College of Graduate Studies of Sudan University of Science and Technology, is my original work. All sources of literature and materials used for this study have been duly acknowledged. I also agree that the Sudan University of Science and Technology has the sole right to the publication of this dissertation.

……..... …….

Signature Date

Ahmed Elzebeir Mustafa Mahmoud

College of Graduate Studies

Sudan University of Science and Technology

RECOMMENDATION

This thesis has been submitted for my approval to the University supervisor.

…… ……

Signature Date

Prof. Dr. Ayoub Zeyada Elhag

College of Graduate Studies

Sudan University of Science and Technology

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DEDICATION

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Abstract

The study was carried out thru 7 July - 1 October of 2015 in a cooled plastic tunnel (29ºc Temperature and 85%, Relative humidity) at Al Bagair area, in the northern part of Al Gazera State, Sudan, to study the effect of organic (Elkhierat), bio-fertilizer (Elixir) and chemical (NPK) and some micronutrients (Fe, Zn and B at 200, and 100 ppm, respectively) fertilizers and their combinations on growth, yield and quality of cucumber (*Cucumis sativus* L.) variety (Faten). The treatments were Elkhierat 1kg/m^2) or NPK **(**12g/m^2**)** alone and their combinations with Elixir **(**1kg + 12mL/m^2) or micro-nutrients (1kg + 12g/m^2). Elkhierat was incorporated in the soil before sowing. Other fertilizers (NPK and micro-nutrients) were dissolved in water (1g/Liter) in addition to Elixir (1ml/Liter) and added to the plants accordingly to the varied treatments weekly. Magnesium sulphate (2kg) and calcium nitrate (2kg) each huose were added at the third week. The experimental design was a randomized complete block design [RCBD] with four replications. The growth parameters recorded were plant height, number of leaves and flowers per plant, whereas, the yield and fruit quality parameters recorded were number of fruits per plant. yield per plant, fruit weight, early and total yield per plant and per unit area in addition to fruit length and diameter for quality. The results showed that the highest significant values of both shoot growth and yield were obtained with the organic (Elkhierat) or NPK and elixir (281.8, 270.5cm) and (13.6, 13.3kg/m^2, respectively) or micro- nutrients (211.5cm) and (13.5kg/m^2) combinations. The lowest values of both were obtained with NPK or Elkhierat alone (187.8, 161.3cm) and (10.6kg/m^2) no significant effects of fertilizer between combinations of (Elkhierat) and NPK with elixir or micro- nutrients (15.3cm) and (3.3, 3.2cm) on fruit quality were noticed,

while the lowest values of both obtained with NPK or Elkhierat) alone (14.1, 14.2cm) and (2.8cm). It could be concluded that for the highest cucumber growth and yield under cooled conditions (evaporative cooling system) could be obtained with NPK or organic with bio-fertilizer or micro-nutrients combinations. Organic and micro-nutrients or bio-fertilizer combinations, however, could be recommended for optimum organic cucumber production under cooled plastic tunnels of Alghazira and Khartoum States. Further studies would be required to find the optimum fertilizer rate and time of application.

تأثير بعض أنواع الأسمده علي نموء و إنتاج وجودة الخيار تحت ظروف الأنفاق البلاستيكية المبردة

المستخلص

أُجريت هذه الدراسة في الفترة من يوليو-اكتوبر 2015 تحت الانفاق البلاستيكية (29 º م و85% رطوبة نسبية) بمنطقة الباقير في شمال ولاية الجزيرة – السودان ، وذلك لدراسة أثر الأسمدة العضوية(الخيرات) والكيميائية (NPK) والمخصبات الحيوية(الاكسير) و المغذيات الدقيقة (الحديد، الزنك والبورون بمعدل 200 ,100جزؤ من المليون علي التوالي)، وتوافيقها علي نمو، انتاج وجودة صنف الخيار"فاتن" . كانت المعاملات كالأتي: (سماد الخيرات العضوي فقط: 1كجم/م^2، الخيرات + الإكسير: 1كجم/م^2 + 12 مل/م^2، الخيرات + المغذيات الدقيقة: 1كجم/م^2 + 12 جم/م^2، NPK فقط: 12 جم/م^2، NPK + الإكسير: 12 جم/م^2 + 12 مل/م^2، NPK + المغذيات الدقيقة: 12 جم/م^2). تم خلط سماد الخيرات بالتربة قبل الزراعة، أما سماد الـ NPK والسماد الورقي أُذيبت في الماء (1جم/لترماء) والإكسير (1مل/لتر) أُضيفت الي التربة للنباتات إسبوعياً وفقاً لاختلاف المعاملات. كما تمت إضافة 2كجم/بيت سلفات ماغنسيوم و 2 كجم/بيت نترات كالسيوم فى الأسبوع الثالث من الزراعة. كانت الوحدات التجريبية في تصميم القطاعات الكاملة العشوائية باربعة تكررات. تم تقييم النمو الخضري وفقا لطول النبات، عدد الأوراق والأزهار في حين تم تقييم الانتاج وفقا لعدد الثمار, وزن الثمرة, الانتاج المبكر والكلي للنبات ولوحدة المساحة ,هدا بالاضافة لطول وقطر الثمرة للجودة. أوضحت النتائج أن اعلي قيم معنوية للنمو والانتاج معا حصل عليها باستخدام توفيقي العضوي (الخيرات) اوالمعدني (NPK) مع السماد الحيوي او العناصر الدقيقة (8 .281 ,270.5سم) و(13.6 , 13.3 كجم/م^2 علي التوالي) مقارنة بمعاملات كومبوست الخيرات أو الـ NPK فقط (187.8,161.3سم) و(10.6 كجم/م^2) . لم تتم ملاحظة اي تاثير معنوي بين اسمدة الخيرات وال NPK مع الاكسيراو المغذيات الدقيقة (15,3سم) و(3,3-3,2سم)علي جودة الثمار.بينما اقل قيمة تم الحصول عليها معا في معاملات الخيرات وال NPK

فقط(14,1-14,2سم) و(2,8). عليه يمكن أن نخلص الى إمكانية الحصول علي أعلي معدل نمو وإنتاج للخيار داخل الأنفاق البلاستيكية المبردة (نظام التبريد الصحراوي) بإسخدام مخلوط الأسمدة الكيميائية المركبة (NPK) أو الأسمدة العضوية مع المخصبات الحيوية أو المغذيات الدقيقة. عليه يمكن التوصية بإستخدام مخلوط الأسمدة العضوية مع المخصبات الحيوية أو المغذيات الدقيقة للإنتاج العضوى المثالى للخيار داخل الأنفاق البلاستيكية المبردة بولايتي الجزيرة والخرطوم. كما مطلوب مزيد من الدراسات لمعرفة المعدلات المثلي وتوقيت إضافتها.

CHAPTER ONE

INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the family Cucurbitaceae and is extensively cultivated vegetable. It is one of the oldest vegetable crops that grown widely throughout the world. It is a warm season crop with temperature requirements of 26 to 30°C and plenty of sunlight. It has been commonly cultivated during summer and fall seasons as well as in low tunnels, plastic and glass houses in winter. The total cultivated area of cucumber in the Arab countries is about 129.6 thousand hectares with the productivity of 17.5 t/ha. The total cultivated area over the world is about 2.4 million hectares with an average production of 45764 thousand tons (Saeed *et al*., 2015).

Cucumber is one of the most important vegetable crops in Sudan. Recently it is produced under cooled plastic tunnels, a new technology, introduced in the last two decades. This production technologies and their suitable construction materials and forms to reduce the high initial and operational costs of protected production are still under research. One of them is to attain the suitable types and amounts of fertilizers, especially macronutrients. In the last century, chemical fertilizers were largely used. Recently the interst in organic production is increased due to the detrimental effects of excessive chemical fertilizers specially nitrogen, in addition to their high costs.Sudan weather conditions are characterized by having predominantly long and hot summers and short and mild winters.Such climatic conditions put a great strain on the types of crops that could be successfully grown under greenhouses (Salah and Azmi 2015). Cover used in greenhouses in Sudan was agreed with the standard specification, but not agreed with the standard length,width,and height.Irrigation in all greenhouses in Sudan is by drip irrigation,result in salt accumulation this require leaching process,but this process dose not find an

interst in greenhouses (Salah and Azmi 2015). Also,in Sudan there is no interst for cleaning and sterilization which lead to increase infection by diseases,pests and insects.Cultural practices (land preparation, sowing date,variety or cultivar, soil type and its fertility, irrigation quantity and quality, fertilization dose and time of application, insecticides, pesticides and herbicides)do not appply coeerct in greenhouses in Sudan(Salah and Azmi 2015).

The objectives of this study were to test the effects of NPK and organic fertilizers on cucumber production under evaporative cooling and the possibility to increase cucumber growth and yield without usage of excessive use of NPK or organic fertilizer with bio-fertilizers and some micronutrients combinations

CHAPTER TWO

LITERATURE REVIEW

2.1 Cucuber

2.1.1 Growth habit

The plant is a coarse, prostrate annual creeping vine that grows up trellises or any other supporting frames, wrapping around ribbing with thin, spiraling tendrils. The plant has large, prickly, hairy triangular leaves that form a canopy over the fruit, and yellow flowers which are mostly either male or female. The female flowers are recognized by the swollen ovary at the base which will become edible fruits.

The vegetative growth consists of 2 stages: stage (I) upright growth- It is the initial stage that starts when first true leaves emerge and it end after 5-6 nodes.Stage (II) vining , which starts after 6 nodes. The side shoots begin to emerge from leaf axils, while the main leader continues to grow. Side shoots are also growing, causing the plant to flop over. Leaves are simple and develop at each node. Each flower and fruit is borne on its own stem attached to the main stem at a node. Depending on variety and environmental conditions, flowers may begin developing at the first few nodes (Khoshnevisan *et al*., 2014).

2.1.2 Nutritional and health values

The fruits are eaten raw with salt and pepper at the immature and mature stages. The small fruits are usually used for pickling and the big ones used for salads and cooking curries. The mature fruits contain 96.3 percent water, 2.7 percent carbohydrates. 0.4 percent protein, 0.1 percent fat and 0.4 percent minerals. It is a good source of vitamin B,C and A. It also contains potassium, manganese, magnesium, and amino acid tryptophan (Staub and Navazio,

1993). The high water content makes cucumbers a diuretic and it also has a cleaning action within the body by removing accumulated pockets of old waste material and chemical toxins. Cucumbers help eliminate uric acid which is beneficial for those who have arthritis, and its fiber-rich skin and high levels of potassium and magnesium helps regulate blood pressure and help promote nutrient functions. The magnesium content in cucumbers also relaxes nerves and muscles and keeps blood circulating smoothly (Khoshnevisan *et al*., 2014).

2.1.3 Climatic requirements

Cucumber responds like a semi-tropical plant. It grows best under favorable and stable environmental and nutritional conditions and pests control (conditions of high temperature, humidity, light intensity and with an uninterrupted supply of water and nutrients). On the other hand, cucumbers are very sensitive to unfavorable conditions, and the slightest stress affects their growth and productivity. Young plants are seriously injured by frost, average daily temperatures are 18.3-23.9°C (Wayne *et al*., 2002).

. Good soils for green house cucumber should be well drained, at least 1.22-meter-deep, low in soluble salts, and free of soil-borne diseases. Sandy loom is preferred to sand or clay. If the green house soil does not meet these criteria, several types of soilless growing systems can be used successfully (Engindeniz and Engindeniz, 2006). Although cucumber is tolerant to the strongly acid soil, the best result will be obtained if the soil reaction is kept between 5.5-6.8 pH.

2.1.4 Cultivars

Cultivars selected should grow vigorously, yield well, resist disease, and have desirable market characteristics. The selection of varieties will also depend upon the use for which product is intended. Some cultivars are best suited for

slicing and others are especially desirable for pickling (Roosta *et al*., 2009).

Hybrid cultivars have been developed incorporated a genetic factor known as the gynoecious flowering habit. Plant with the gynoecious flowering habit produces only female flowers. Normally cucumber plants are monoecious, so that can produce both male and female flowers separately on the same plant (Yamasaki and Manabe, 2011). This genetic character has been incorporated into breeding lines and can be retained in successive generations by treating the plant with gibberellic acid to produce a few male flowers for self-pollination.

2.2 Cultural practices

2.2.1 Planting and plant growth

Green house cucumber grows rapidly under optimum environmental conditions, and fruit production begins 6o-70 days after sowing. Planting dates vary with the treatment applications. Planting of green house cucumber is ordinarily of increasing interest world widely. Moreover its organic production becomes of increasing interest.

Planting starts from seedlings, but direct seeding in green house beds may also be practiced for late summer or early fall plantings if the time from seeding to fruiting may not be as critical, and prevailing temperatures are warm enough for good seed germination without artificial heating. Midwinter direct seeding is not recommended because it delays fruit production by 3 to 4 weeks and requires more fuel to promote growth. Transplanting makes more efficient use of greenhouse space because seed germination and early growth of the plant can be confined to a smaller nursery area. Disadvantages of transplanting are the costs of containers and the labor, costs of transplanting (Mami and Peyvast, 2010).

The nursery should be equipped with waste- high benches and environmental control equipment. The temperature should be maintained constant at 29 to 44°C (night and day) to accelerate germination. Supplemental lighting provision will minimize the time from seeding to the three-leaf stage for transplanting. Frost easily injures cucumbers, consequently, field planting should be delayed until the soil temperature reaches 15.6°C and the danger of frost is over. Some experienced growers make two or three different planting, a week apart, the first about 10 days before the average date of the last killing frost. If frost does not kill the first planting it will give an extra early crop. If the first planting is killed the grower still has one more of the later planting to fall back on.

2.2.2 Production under controlled condition

2.2.2.1 Spacing

Planting spacing depends on the growth habit, variety and harvesting method.Close spacing increases yields, provides more uniform maturity and reduces weed problems. It also results in shorter fruit with a lighter color.On the other hand, high plant population requires more seeds and slightly higher fertilizer rates (Khoshnevisan *et al*., 2014).

2.2.2.2 Training

Cucumber plants are supported by strings suspended from a horizontal wire. The wire is attached to the top of the wall at each end of the green house (Khoshnevisan *et al*., 2014), so that it is located 7 to 8 feet above the plant rows. Heavy sisal or polyethylene twine is used for the support strings.

2.2.2.3 Pruning

The plants grow rapidly and produce heavily. The main stem, laterals, and tendrils grow fast. They need frequent pruning to a single stem and training

along vertical wires to maintain an optimal canopy that intercepts maximum light and allows sufficient air movement. Under optimum conditions, more than one fruit may initially develop from the axil of each leaf that may need more efforts to support to reach full size, instead they should be thinned to the minimum to have high fruit quality. Excessive plant vigor is indicated by rapid growth, thick and brittle stems, large leaves, long tendrils, deep green foliage, and large, deep yellow flowers. Because fruit develops only in newly produced leaf axil, major pruning may be needed to stimulate growth. The removal of entire weakened laterals is more effective than snipping back their tips (Khoshnevisan *et al*., 2014).

The growers have different pruning ways on cucumber's growth to improve yield and quality.

2.2.2.4 Cultivation

Cultivation should be started as soon as the plants are up and continued frequently enough to keep the weeds down and the soil loss. Early cultivations may be near to the plants, but since the cucumber is shallow-rooted (Guo *et al*., 2008), all cultivations after the plants begin to run should be shallow and not too close to the plants.

2.2.2.5 Irrigation

Cucumber crop requires a continuous supply of moisture during the growing season (Alsadon *et al*., 2006). The most critical need occurs at the time of fruiting. Moisture stress then can severely reduce the yield of marketable fruit. Furrow irrigation is preferable where it can be used. When an overhead system is used, water should be applied early enough in the day so that the soil and leaves can dry before nightfall to reduce the spread of fruit rotting and foliage diseases.

2.2.2.6 Control of pest and diseases

The most important diseases are downy mildew, bacterial wilt, anthracnose, root knot, angular leaf spot, mosaic, and scab (Weng, 2008).

The principal cucumber insects include aphids, twelve-spotted and striped cucumber beetles, and spider mites (Webb, 2017).

2.2.2.7 Pollination

Cucumbers either require insects, chiefly honey bees, and wild or domesticated, to transfer pollen from male to female flowers for the development of usable fruit (Nicodemo *et al*., 2013).

2.2.2.8 Harvest

The fruits will be ready for harvesting when they are about 6 to 10 inches long and 1.5 to 2.5 inches in diameter. They should be dark to medium green, without any signs of yellowing. On average, 58 to 65 days are required from seeding to maturity, depending on the cultivar and the growing conditions. Fresh-market cucumbers are harvested by hand. Because the individual fruits do not develop and mature consistently, the timing of maturity is not uniform within a field. As a result, fresh-market cucumbers typically are picked between 6 to 8 times over a three weeks period. In some situations, fresh-market cucumbers can be picked up to 12 to 15 times in a season. The number of pickings depends on when the seeds are planted and the supply and demand situation in the market. Price is a major factor in picking time. Once prices for cucumbers fall below a certain level, it becomes uneconomical for growers to continue harvesting.

Cucumber crop matures within 40-50 days, and harvesting starts 45-55 days after planting. Harvest during summer to early fall depending on planting time, and variety. Cucumbers should be harvested at 2-4day intervals, when

the fruits have reached the desired size, to avoid losses from oversized and over-mature fruit.

2.3. Effect of fertilizer type on growth and yield of cucumber

Increased attention is now being paid to developing an Integrated Plant Nutrition System (IPNS) that maintains or enhances soil productivity through balanced use of all sources of nutrients, including chemical, organic and biofertilizers. The basic concept underlying the IPNS is the adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner.

2.3.1 Organic fertilizers

To improve agricultural productivity and soil fertility addition of organic matter such as animal manure to the sodic soils is necessary, because of its limited organic materials (Farah *et al*., 1990; and Mubarak, 2003).

Generally in order to maintain and increase aggregate stability and soil fertility on farming and gardening usage of compost manure in fertilizer is vevy important and it had been of particular importance in past decades. The organic fertilizers can contain the concentration of three major nutrients in the material: nitrogen (N), phosphate (P2O5), and potassium (K2O), Many organic fertilizers also contain other nutrients like sulfur, iron, and zinc beside the main nutrients. Regular use of organic fertilizers also increases soil organic matter levels, which improves soil physical properties like water holding capacity, drainage, and tilt (the physical condition of soil related to structure and the ease of tillage). In addition it helps reduce costs and waste disposal. It will lead to more efficiency and usefulness (Lalande *et al*., 2000) and Vollmery (1999) reported that addition of compost as mulch in cucumber

had increased farm production. It has been observed that applications of compost and NPK on cucumber plants gave better response on growth and yield (Abdrabbo and Desoky, 2014 and Singh *et al*., 2010) On the other hand, the relatively slow mineralization of the composts and other organic fertilizers limits the effective nitrogen utilization. The low availability of nitrogen in organic fertilizers is the main underlying factor contributing to the low yield in organic farming and as 'The principal objections to the proposition that organic agriculture can contribute significantly to the global food supply are low yields and insufficient quantities of organically acceptable fertilizers.

2.3.2 Chemical fertilizers (NPK and micronutrients)

Each type of plant is unique and has an optimum nutrient range as well as a minimum requirement level. Below this minimum level plants start to show nutrient deficiency symptoms. Excessive nutrient uptake can also cause poor growth because of toxicity. Therefore, the proper amount of application and the placement of nutrients is important. studied the influence of integrated nutrient management on growth and yield parameters of cabbage and tomato under mid hill conditions of Himachal Pradesh and concluded that farmyard manure 10t/ha + 150%NPK recorded highest values for growth, yield and available nutrients (nitrogen, phosphorous and potassium), also significant increase in curd weight, curd diameter, plant height and curd yield of cauliflower with application of 50% NPK + organic maure.

Commercial production of cucumbers and other vegetables has increased steadily under green house as a camper to severe climate (Krug *et al*., 2007).

Green house cucumbers are grown in many soil-based and soilless cultural systems, depending on the production area, the relative threat of soil born diseases, and the availability of soilless media (Jasso-Chaverria *et al*., 2005)

Schon and Compton (1997a) found that yield of European-type green house cucumbers on Rockwool medium increased with N concentration up to 225 mg/l. Hochmuth (2001) recommended 240 mg N/l for cucumber during fruiting in Florida. Adhikari (2014) reported that increased nitrogen application resulted in maximum vine length, fruit length and fruit weight, and yield of cucumber. Also Siva *et al*. (2017) and Danesh *et al*. (2012) found that 100 kg N\ha significantly maximized cucumber vine length and fruit weight and length, which were directly related to the yield .

Application of NPK 140-60-150 kg\ha exhibited better results for highest germination percentage, vine length, more fruits per vine, maximum fruit diameter and weight, and total cucumber yield. It delayed, however, days to flowering, fruit setting and maturity (Anuja and Poovizhi, 2010). Moreover, Phu, (1996) reported that N and K fertilizer applications had significant effect on the yield of cucumber varieties. Nitrogen and potassium rate at 100-100 kg\ha gave significant positive effects on main stem length, number of branches and fruits, and yield. Nevertheless, hey found that application of 150: 90: 90 kg NPK\ha through fertigation gave maximum number of fruits per vine, fruit weight and yield per plant and per hectare of cucumber. Ruiz and Romero (1998) reported that increasing the level of NPK had positive response on cucumber vegetative growth and increased yield. Eexcessive N fertilization, however, reduced cucumber fruit quality in loamy sand soil in green house in Spain.

The recommendation for greenhouse vegetable producers using soilless cultural system is to allow for a fraction of the nutrient solution to leach from the medium, after each irrigation, to minimize soluble salt build-up in the medium (Hochmuth, 2001). The duration of N concentration in the nutrient solution increased (Schon and Compton 1997b), pointing to the need to

manage N and leaching fraction together to minimize N losses from the medium, which could lead to N contamination of the ground beneath or around the greenhouse. Danesh *et al*. (2012) reported the effect of nitrogen and biofertilizers on growth and yield of cabbage (cv Pride of India). Biofertilizer application significantly increased the leaf number, weight of non wrapper leaves per plant, head length and width, gross and net weight of head per plant and yield per hectare over no biofertilizer application.

2.3.3 Bio-fertilizers

They are known as mixtures of micro-organism's activators which can be bacteria, actino-mycetes, yeasts, and molds. Rao *et al*.(2014) reported that bio-fertilizers are soil organisms or their metabolic products that are used to provide plant nutrients to an agronomic ecosystem. Bio-fertilizers are used to substantially reduce the use of chemical inputs and to increase sustainability. Studies conducted on medicinal plants in natural and agronomic ecosystems indicate that the use of bio-fertilizers provide the necessary conditions for high yield with high quality (Radwan, 1990 and Rao *et al*., 2014). Nagananda *et al*. (2010) and Yanni *et al*.(2001) rreported that the use of bio-fertilizers with chemical fertilizers could enhance plants height, leaf chlorophyll content, shoot fresh and dry weight and the amount of macro and micronutrients absorbed by plant roots. Yield, fruit number and weight, fruit quality and the number of days to harvest varry in the modified cucumbers and as special planting in the greenhouse. Cucumber plants produce female flowers and such cultivars are known as gyneous cultivars. These cultivars have high efficiency compared to monoecious varieties which have the male and female flowers place on the same plant (Kater *et al*., 2001).

Excessive use of chemical fertilizers and pesticides in agricultural ecosystems make some problems such as environmental pollution, soil erosion, food chain restriction, pest resistance to pesticides. In addition, human and environmental problems, arised necessitate non-chemical methods of soil fertilization Use of organic fertilizer and biological control plays an important role in these contexts (Chandra *et al*., 2016).

CHAPTER THREE

MATERIALS AND METHODS

3-1 Experiment Site

The experiment was conducted in (7, July to 1, October 2015) in a cool plastic tunnel of 100 m^2 area (using an evaporative cooling system of the exhaust fans and pads) at Al-baggier, in the northern part of Al gezira State- Sudan, at latitude 14º,12' N and longitude 33º,29'29"E and elevation of 385m above sea level.

3.2 Materials and methods

3.2.1 Plant materials

Improved hybrid cucumber (*C.sativus* L.) variety 'Faten' was used. The seeds were obtained from a seed shop in local market -Sudan.

3.2.2. Fertilizers

Three types of fertilizer (Al khierat compost, micronutrients: (Fe, Zn and B) and NPK were also obtained from a seed shop in local market – Sudan. In addition to the bio-fertilizer (Elixir) was obtained from Bioactivater Factory for Agricultural Fertilizers, the Industrial Area, Khartoum North.

3.2.3 Fertilizer Combinations:

The treatments consisted of the different levels of fertilizers (Elkhierat compost, NPK, micronutrients and Elixir). The fertilizers were prepared in six levels as follows:

(i) Elkhierat Compost alone 1kg/m^2

(ii) Elkhierat Compost + Elixir (1kg + 12ml/m^2)

(iii) Elkhierat Compost + micronutrients (1kg+ 12g/m^2

(iv) NPK alone (12g/m^2)

(v) NPK + Elixir (12g +12ml/m^2)

(vi) NPK + micronutrients (12g +12g/m^2).

3.3 Methods

3.3.1 Cultural practices:

The experimental units were ploughed three times using a small hand machine. The plot was divided into six 70-cm ridges and then divided into 0.7x4 m experimental units. Elkhierat compost was added and mixed with soil before sowing. The units were pre-irrigated two days before sowing. Dressed seeds (with fungicide Captan at 2,4g/kg seed) of hybrid Faten were sown directly on both sides of the ridges (20 cm from each edge) at 50cm spacing. Temperature and relative humidity at sowing were 29ºC and 85%, respectively. The cultural practices such as irrigation (drip system), weeding, pests and diseases control, and harvesting were applied as recommended by Agricultural research corporation. The temperature and the relative humidity during the growing season were 22±3ºC and 65-75%, respectively. The plants were irrigated every 2nd-day. NPK and micro-nutrients fertilizers were dissolved in water (1g/L) in addition to Elixir (1ml/L) were added to the soil for each plant weekly. According to Khoshnevisan *et al*.(2014) training and pruning were done by removal of all lateral branches as they develop until the plant reaches the overhead support wire. Then the terminal bud was not removed after the second leaf above the wire, and last two lateral branches were allowed to grow. They were trained over the wire and allowed to grow downward to about 91cm above the ground.

3.4. Data collected

3.4.1 Vegetative growth

The growth parameters were evaluated as plant height, number of leaves and flowers per plant as follows:

3.4.1.1 Plant height (cm):

Five plants per plot were randomly selected to measure plant height every 7days using metering tape. The length of the stem from the soil surface to the tip of the plant was measured and the average plant height was recorded.

3.4.1.2 Number of leaves:

The number of leaves of the same selected plants was counted weekly and their average number per plant was recorded.

3.4.1.3 Number of flowers/plant:

The number of flowers of the same selected plants were counted weekly and the average number per plant was recorded.

3.4.2 Yield and yield components

They were evaluated as number of fruits per plant, fruit weight and yield per plant and per m^2 as follows:

3.4.2.1 Number of the fruits/plant:

The number of fruits of the same plants at each harvest was recorded, and the average number of fruits per plant was calculated.

3.4.2.2 Fruit weight:

Five fruits from each plot at harvest were randomly selected weighed and the average fruit weight was calculated.

3.4.2.3 Fruit Yield per plant:

The total yield of the same selected plants was recorded and the average yield per plant was calculated.

3.4.2.4 Yield per unit area (m^2):

The total yield of each plot was recorded and yield per m^2 was calculated as follows.

Yield (kg/ m^2) = total yield (kg/plot) / plot area (m^2).

3.4.3 Fruit quality:

3.4.3.1 Fruit diameter:

The diameter of the same selected fruits was measured using a vernier (MNT-150, CHINA) and the average diameter was calculated.

3.4.3.2 Fruit length:

The fruit length of the same selected fruits was measured and the average fruit length was calculated.

3.5 Experimental design and data analysis

The experimental units were in a completely randomized block design (CRBD) with four replications, Analysis of data was done using software GenStat. Treatments means were separated using Dancans Multiple Range Test [DMRT] at P≤ 5%. (Gomez and Gomez,1984).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Vegetative growth

4.1.1 Plant height and number of leaves and flowers per plant.

After five weeks from planting (Table 1) the highest plants (213.8 cm), were obtained by the combination of Elkhierat Compost wiht Elixir followed by NPK with micro-nutrients or NPK with Elixir (204.3, 198.9 cm, respectively). The lowest plant height (161.3 cm) was obtained by Elkhierat compost alone. After seven weeks from planting no significant differences in plant height between the combinations of Elkhierat compost with Elixir or NPK with micro-nutrients were noticed, however, they gave the highest plants (281.8 and 270.5 cm,respectively). Similarly the lowest plant heights were recorded by the combination of Elkhierat compost with micro-nutrients or NPK alone (211.5 and 213.0 cm, respectively. Similar results were also noticed by the number of leaves per plant in response to both fertlizer combinations (75.6 and 73.5 leaves per plant, respectively), compared to fertilizers alone (63.3 and 61 leaves per plant, respectively) both after 5 and 7weeks from planting (Table 2). The number of flowers per plant (Fig..1) showed the same response to fertilizer combinations compared to single fertilizers. The combination of Elkhiarat with micro-nutrients, however, gave the highest number of flowers per plant. Similar results were obtained by Karlen and Camp (1985) who stated that composting could-

Table 1: Effect of chemical, organic and bio-fertilizer and their combination on plant height of cucumber (cv. Faten) after five and seven weeks from planting under cooled plastic tunnels conditions.

Fertilizer type and dose	**Plant height (cm)**	
	after 5 weeks	**After 7 weeks**
Compost alone (1kg/m^2)	161.3^e	237.0^b
Compost and Elixir (1kg+12mL/m^2)	213.8^a	281.8^a
Compost and minor (1kg+12g/m^2)	168.5^d	211.5^c
NPK alone (12g/m^2)	187.8^c	213.2^c
NPK and Elixir (12g+12mL/m^2)	198.9^b	252.0^b
NPK and minor (12g+12g/m^2)	204.3^b	270.5^a
C.v.	2.0	4.4

Means within the same column having the same alphabetical letters were not significantly different using Dancans Multiple Range Test at $P \leq 0.05$.

Table 2: Effect of fertilizer type (Elkhierat compost, Elixir, NPK and minor-nutrients and their combination on number of leaves per plant of cucumber (cv. Faten) after five and seven weeks from planting under cooled plastic tunnels conditions.

Fertilizer type and dose	**Leaves number/plant**	
	after 5weeks	**after 7weeks**
Compost alone (1kg/m^2)	63.3^{d}	83.1 c
Compost and Elixir (1kg+12mL/m^2)	73.5^{ab}	104.2^{ab}
Compost and minor (1kg+12g/m^2)	70.3^{bc}	105.3^{a}
NPK alone (12g/m^2)	61.0^{d}	81.2^{c}
NPK and Elixir (12g+12mL/m^2)	75.6^{a}	102.2^{b}
NPK and minor (12g+12g/m^2)	68.2^{c}	101.4^{b}
C.v.	3.9	1.8

Means within the same column having the same alphabetical letters were not significantly different using Dancans Multiple Range Test at $P \leq 0.05$.

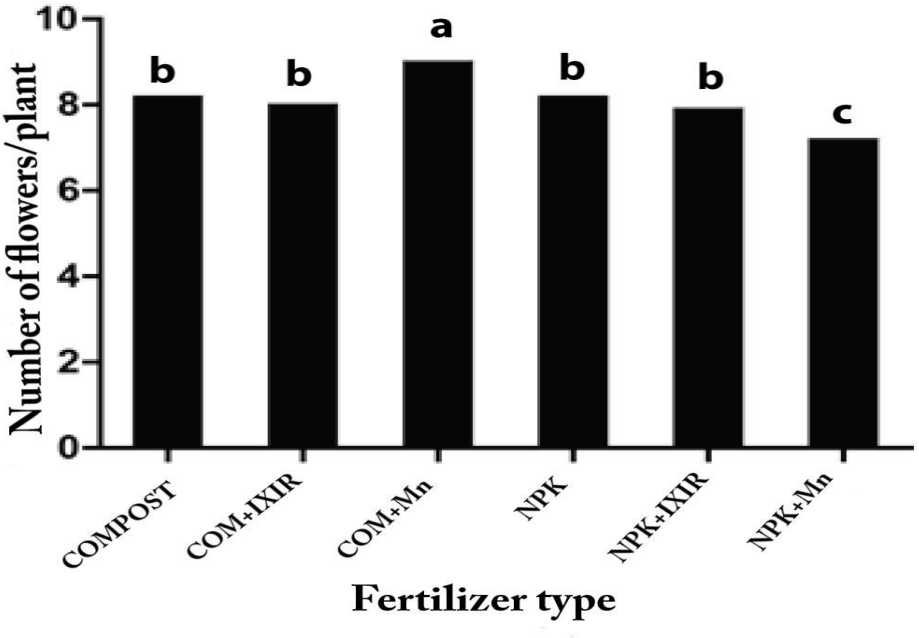

Fig.1: Effect of fertilizer types (Elkhierat compost, Elixir, NPK and minor-nutrients and their combination on number of flower per plant of cucumber (cv. Faten), under cooled plastic tunnels conditions.

Means having the same alphabetical letters were not significantly different using Dancans Multiple Range Test at $P \leq 0.05$.

improve soil porosity, soil water capacity and soil fertility that to better plant growth. Moreover, (Ebrahim et al., 2010 and Shafiee finally led Zargar,1996) reported the positive effects of cow manure and urban waste compost on plant height. Nasohi (2004) stated that NPK and organic fertilizers in combinations with biofertilizers are nutrients that are directly related with the growth and yield of the plants especially in terms of number of the leaves and plant height. Nagananda et al. (2010) and Yanni et al.(2001) reported that the use of bio-fertilizers with chemical fertilizers could enhance plants height, leaf chlorophyll content, shoot fresh and dry weight and the amount of macro and micronutrients absorbed by plant roots.

4. 2. Yield and its components

4.2.1. Fruits number/plant and weight

As shown on (Table 3), no significant differences among fertilizers and their combinations (Elkhierat compost with Elixir, Elkhierat compost with micro-nutrients, NPK alone, NPK with Elixir and NPK with micro-nutrients) on fruits number/plant were noticed. Elkhierat compost alone, however, showed the lowest number of fruits/plant (39 fruits). The same results were reflected on fruit weight . The combinations of Elkhierat compost with Elixir, Elkhierat compost with micro-nutrients, NPK with Elixir or NPK with micro- nutrients, however, gave the heaviest fruits (127.5,128.4, 127.9 and 127.3g/fruit, respectively). Similar results were found by Salardini (1993) and Shafiee and Zargar (1996).

4.2.2. Yield per plant and early and total yield per unit area (m^2).

As in (Table 4) the combination of Elkhierat compost with Elixir gave the highest yield (4.5 kg/plant) followed by the combinations of Elkhierat compost with micro-nutrients or NPK with micro-nutrients (4.5 and 4.4 kg/plant), respectively. The lowest yield (2.9 and 3.4 kg/plant), respectively was obtained by Elkhierat compost and NPK alone.

The results in the same table reflected no significant differences in early (the 1st ten harvests) yield among both fertilizer types (compost and NPK)with Elixir or micro-nutrients (7.2 kg/m^2). The early yield obtained, however, was significantly higher than yield obtained with compost (4.5kg/m^2) or NPK (4.2kg/m^2) alone.

Similar results (Table 4) were obtained by yield per unit area (m^2). The combinations of both Elkhierat compost or NPK with Elixir or micro-nutrients gave the highest yields (13.6kg/m^2) which were significantly higher than yields obtained by Eljkhierat or NPK alone (10.6 kg/m^2). Similar results for yield and its components were found by Salardini and Mojtahedi (1988), Salardini(1993) and Shafiee and Zargar (1996). Vollmery (1999) reported that addition of compost as mulch in cucumber had increased farm production. Moreover, Abdrabbo and Desoky (2014) and Singh *et al*. (2010) observed that applications of compost and NPK on cucumber plants gave better response on growth and yield. Studies conducted on medicinal plants in natural and agronomic ecosystems indicate that the use of bio-fertilizers provide the necessary conditions for high yield with high quality (Radwan, 1990 and Rao *et al*., 2014).

Table 3: Effect of fertilizer type (Elkhierat compost, Elixir, NPK and minor-nutrients and their combination on fruit number/plant and fruit weight of cucumber (cv. Faten) under cooled plastic tunnels conditions.

Fertilizer type and dose	**Fruits number/plant**	**Fruit weight (g)**
Compost alone (1kg/m^2)	39.4[b]	117.9[b]
Compost and Elixir (1kg+12mL/m^2)	50.4[a]	127.4[a]
Compost and minor (1kg+12g/m^2)	46.7[a]	128.4[a]
NPK alone (12g/m^2)	46.2[a]	116.6[b]
NPK and Elixir (12g+12mL/m^2)	50.4[a]	127.9[a]
NPK and minor (12g+12g/m^2)	45.7[a]	127.3[a]
C.v.	1.8	1.1

Means within the same column having the same alphabetical letters were not significantly different using Dancans Multiple Range Test at $P \leq 0.05$.

Table 4: Effect of fertilizer type (Elkhierat compost, Elixir, NPK and minor-nutrients and their combination on yield/plant and early and total yield/m^2. of cucumber (cv.Faten) under cooled plastic tunnels conditions.

Fertilizer type and dose	**Yield (kg/plant)**	**Early yield (kg/m^2)**	**Yield (kg/m^2)**
Compost alone ($1kg/m^2$)	2.9^b	4.5^b	10.6^b
Compost and Elixir ($1kg+12mL/m^2$)	4.5^a	7.2^a	13.6^a
Compost and minor ($1kg+12g/m^2$)	4.5^a	7.2^a	13.5^a
NPK alone ($12g/m^2$)	3.4^b	4.2^b	10.6^b
NPK and Elixir ($12g+12mL/m^2$)	4.4^a	7.2^a	13.3^a
NPK and minor ($12g+12g/m^2$)	4.4^a	7.2^a	13.3^a
C.v.	1.5	4.3	1.2

Means within the same column having the same alphabetical letters were not significantly different using Dancans Multiple Range Test DMRT at $P \geq 0.05$.

Moreover, Phu, (1996) reported that N and K fertilizer applications had significant effect on the yield of cucumber. It delayed, however, days to flowering, fruit setting and maturity. Nevertheless, they found that application of 150: 90: 90 kg NPK\ha through fertigation gave maximum number of fruits per vine, fruit weight and yield per plant and per hectare of cucumber.

4 2.3. Fruit quality (fruit length and fruit diameter)

No significant effects on fruit length (Table 5) due to fertilizer types or their combinations were noticed. Fertilizers alone (Elkhierat compost or NPK), however, gave the shortest fruits (14.2 and 14.1cm, respectively). As in the same table similar effects were noticed on fruit diameter (size). Both fertilizer combinations gave the largest fruits (3.3cm). The diameter were obtained with both fertilizers alone (2.8cm). Similar results were obtained by Adhikari (2014) who reported that increased nitrogen application resulted in maximum vine length, fruit length and weight, and yield of cucumber.

Anuja and Poovizhi (2010) reported that application of NPK 140-60-150 kg\ha exhibited better results for maximum fruit diameter and fruit weight and total cucumber yield. Also Siva *et al*. (2017) and Danesh *et al*. (2012) found that 100 kg N\ha significantly maximized cucumber vine length and fruit weight and length, which were also directly related to the yield.

Table 5: Effect of fertilizer type (Elkhierat compost, Elixir, NPK and minor-nutrients and their combination on fruit quality (fruit length and diameter of cucumber (cv.Faten) under cooled plastic tunnels conditions.

Fertilizer type and dose	**Fruit length (cm)**	**Fruit diameter (cm)**
Compost alone (1kg/m^2)	14.2[b]	2.8[b]
Compost and Elixir (1kg+12mL/m^2)	15.3[a]	3.2[a]
Compost and minor (1kg+12g/m^2)	15.3[a]	3.1[a]
NPK alone (12g/m^2)	14.1[b]	2.8[b]
NPK and Elixir (12g+12mL/m^2)	15.3[a]	3.3[a]
NPK and minor (12g+12g/m^2)	15.3[a]	3.2[a]
C.v.	1.1	3.3

Means within the same column having the same alphabetical letters were not significantly different using Dancans Multiple Range Test at $P \leq 0.05$.

CONCLUSIONS AND RECOMMENDATION

Improving of cucumber (*Cucmis sativus* L.) organic production under cooled plastic tunnels becomes extremely important to meet the increasing demand. According to the recorded results it could be concluded that:

1- No significant effects of organic or chemical fertilizers alone on growth and yield of cucumber under controlled conditions were noticed.

2- Combinations of both fertilizers with bio-fertilizer or micro-nutrients gave significant higher growth, yield and quality compared to single fertilizer.

3- To ovoid the adverse effects of chemical fertilizers and to have an organic cucumber production, combinations of organic fertilizers with bio-fertilizers or micro-nutrients could be recommended.

4- Further studies to have the optimum dose and time of application, however, would be required.

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