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جامعة بوليتكنك فلسطين

Application of anaerobic digester effluent as a fertilizer for vegetation

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Abstract

The agricultural industry includes dairy, slaughterhouse, poultry and farms, is considered an important contributor to the national economy and GDP in Palestine.

This projected aimed at investigation the best way of using digested cow manure as biofertilizers in growing squash plants in tunnel mulching. The production of the crop with organic fertilizer plays a vital role in organic agriculture today, cow farms produce large amounts of manure which contain a high content of organics, nitrogen, potassium and phosphorus .Cow dung is a primary source of plant nutrients and has been used as fertilizer for a long time.

Cow manure was taken collected from Al-Jebreni cow's farm in Al-Dahriah, Hebron governorate, Palestine. The farm has established anaerobic digester which ferments the manure in to liquid and solids bio-effluents.

The experiment consist of 3 treatments (Solid, liqufied and control), and each treatment has 5 replicate laid out in a randomized complete block design. This study was implemented in Al-Dahriah city, Hebron governorate.

Through the measurements made on the seedlings, it was found that the growth was faster in the seedlings of liquid digester, and the amount of production is greater than the other two types of treatments.

ا لإ هـ د ا ء

إلى أمي وأبي العزيزان .... إلى من أ ب أحمل اسمه بكل فخر .... إلى من تعبت وسهرت ..... إلى من مهد لي طريقي لا صل إلى ما أنا عليه الآن. .... إلى من أسكنتني بين ثنايا الضلوع...إلى ينبوع الدفء والحنانالدائم..

لمن تكلل نجاحنا بدعوة منها من قلب صاف.....

إلى إخوتي وأخواتي..... أنتم القناديل المضيئة في ليلي .... إلى الذين وهبوا أرواحهم لهذه الأرض الطاهرة لكيّ نحيا نحن ونكمل المسير.

..... إلى أساتذتي ... إلى من أضاءوا بعلمهم عقولنا ..... أنتم من علمتمونا ووسعتم مداركنا وأفكارنا

إلى شعبتي الرائعة إخوة و أخوات لم تلدهم أمي ... إ

إلى قسم هندسة تكنولوجيا البيئة .... بكافة طلابه وطالباته وكوادر التدريس

إلى الذين حمّلونا الأمانة بعد أن غادروا ...إلى أرواح الشهداء في أرض نرجس الحب أرض فلسطين...

إلى كل من وهب لناولو كلمة.

إليكم جميعا أهديكم هذا البحث.....

والله وليّ التوفيق

الــشكـر

أعوامٌ قد قضيناها وسرنا بها خطوة بخطوة، أشخاصٌ كانوا معنا ولا زالوا.شجعونا بحبّ و أمل ، أعادونا للصواب كلّما حدنا عنه وكانوا هم القدوة المختارة ، و الإلهام المقدّم .

واليوم ونحن نخطو خطواتنا قبل الأخيرة في حياتنا الجامعية نتقدم لهم بما في الكون من كلمات شكرٍ وتقدير، و لهفات حبّ و عرفان .

الشكر لله ،واهب عقلنا ،رازقنا نعمه ... الشكر لله أولا وأخيرا على حسن توفيقه وكريم عون

الشكر.... لكل من أنار دربنا ولم يبخل علينا بمعلومة ...

الشكر لوالدينا

فأرقّ الشكر بدايةً لجامعتنا التي احتضنتنا دوماً، التي رسمت لنا خطوات الحياة و أساس كل علم ، فمنها كان الإبداع.

وأيضا للذين قبِلونا كأبناء فكانوا معنا خطوة بخطوة ، لمشرفينا الكِبار ، الدكتور القدير ماهر مغالسة والمهندسة إيمان...

والشكر يصل لكلّ مدرّس آمن بنا وأخبرنا بأنّا نستطيع، فلولاهم ما خطونا خطوة النجاح هذه...

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List of Contents

Chapter One: Introduction

Chapter Two:Literature Review

Chapter Three:Research Methodology

Chapter Four: Test analysis

Chapter Five : Stage and measuement planting

List of Figures

List of Tables

List of Abbreviations

COD: Chemical Oxygen Demand

BOD: Biological Oxygen Demand

TDS: Total Dissolved Solid

TSS: Total Suspended Solid

SS: Suspended Solids

EC: Electrical Conductivity

AD: Anaerobic digestion

N: nitrate

K: potassium

P: Phosphor

C: carbon

DM: dry matter

GDP: Gross domestic product

Chapter one

Introduction

1.1 Introduction

Recently, people tend to improve the quality of environmental with increasing global population, the gap between the supply and demand for water is widening. Recently, around the world become working on new ways of conserving water.

On farms where there are many animals, that produce large amounts of animal waste on relatively small areas, when many of the waste produced in one place, will try to exploit and take advantage of them. One of the ways that can be used to deal with this situation is by anaerobic digestion.

Anaerobic digestion or indigestion without oxygen is a vital Process to handle organic waste and generate renewable energy in the absence of oxygen. The digestion is the production of this process that used as fertilizer for the soil. The method used in the production of biogas from organic materials biodegradable using micro-organisms in the absence of oxygen. Anaerobic digestion is used either to get rid of organic waste (such as animal manure or human waste), or for the production of biogas, Anaerobic digestion of animal manure and slurries offers several benefits by improving their fertilizer qualities, reducing odors and pathogens and producing a renewable fuel – the biogas.

The digested manure and liquid effluent or liquid fraction are rich in nutrients (N, P and K), approximately half of the N is in organic form; the other half is mineral (i.e. ammonium, NH_4). During anaerobic digestion, all nutrients including nitrogen remain in the reactor. Hence, in contrast to composting, no nitrogen is lost during anaerobic digestion.[5]

The solid fraction is rich in organic matter and still contains a lot of organic N and P. The properties of the solid fraction, if added to soils, are comparable to compost with one major exception: it is relatively richer in lingo-cellulose since lignin was not degraded during anaerobic digestion. This means that the solid fraction of the digester is more susceptible to further decomposition in the soil than compost[5].

Compared with raw liquid and solid manures, the ratio of phosphorus to potassium in the digester is generally better suited for satisfying the nutritional needs of the plant. This, in turn, means that for the digester, the need for additional mineral fertilizer is not as high as for liquid and solid manures that have not been fermented.[6]

Cow dung is a primary source of plant nutrients and has been used as fertilizer for a long time. Recently it got higher value for the production of bio-methane using the anaerobic digester. Anaerobic digestion of cow dung produces a liquid effluent which retains the N, P, and K fertilizer nutrients of the raw cow dung. Digestion reduces pathogen counts and denatures weed seeds in raw dung, and the odors of raw dung are greatly reduced in the effluent, thereby easing the storage, movement, and application of manure nutrients.[7] As a result, anaerobic digestion may increase the fertilizer value of raw manure and could potentially reduce the need for synthetic nitrogenous fertilizers and reduce the energy used in the production process.

This study made on liquid effluent from anaerobic digester was created in Aljibrini farm in **2013**, **the first digester in Palestine**.

1.2 Summary of literature review

Effects of anaerobic digestion on digester nutrient availability and crop growth anaerobic digestion (AD) leads in the process of biogas production to several changes in the composition of the output digester compared of original feedstock that is connected with the contents of the plant of macro- and micronutrients after implementation the process.

The raw material for anaerobic digestion can be from stables, wastes from the food industry, crop residues, municipal waste and dedicated energy crops. About 20-95% of the feedstock organic matter (OM) is degraded during AD process. The remaining output of AD is called digester, it is commonly used as fertilizer[8].

1.2.1 Vegetable production

This paper dealt with the impact of organic fertilizer on soil fertility in the production of vegetables, where the provider is found potassium plant inadequate element, especially for leafy vegetables. It was found that 80% of the nitrogen, 60% of the phosphorus and 90% of potassium its outputs of organic manure.

It was found that in greenhouse that >35% of tomato received>1000Kg nitrogen from organic and inorganic sources .Green house sweet pepper and eggplant removed more nutrients in open fields because of higher yields. Nutrient inputs in organic manures and inorganic fertilizers exceeded crop removals, especially for non–leafy vegetables. Over half of organic manure was in the form of chicken manure.

Values of indicators of soil fertility such as total N, organic matter and available P and K in the surface soil layers of green houses were higher in green houses that had been in use for a longer period of time.[9] Soluble salt content and EC in the 0-5 cm layer were 2.69g and 0.56 MS cm-1 and In green houses Soil PH (1:5 soil/water ratio).

1.2.2 Application of liquid manure for irrigation tomato

Tomatoes need a substantial amount of nitrogen in order to yield a tomato crop. A large amount of phosphorus is also needed for tomato growth. An outdoor crop of tomatoes requires 100-150 kg/ ha nitrogen (N) and 20-40 kg/ha of phosphorus (P), while a greenhouse crop of tomatoes requires 200-600kg/ha N and 100-200 kg/ha P.

1.3 Problem statement

1.3.1 Main problem

This research project will respond to the main question:

1. Vegetables grown with anaerobic digestion effluent will produce a comparable yield to vegetables grown with traditional fertilizers. Anaerobic digester effluent will contain the nutrient levels needed for plants to grow.
2. The application of anaerobic digester effluent as a biofertilizers for vegetation will increase the economic value of the effluent and reduce its impact on the environment.

1.3.2 Sub main Questions:

1. Is it possible to consider anaerobic digester effluent as an alternative to raw manure taken into consideration that it is better for conditioning soil and the plant?
2. What is the effect of anaerobic digestion effluent on yield crops?
3. Is such application affordable to the farmers in terms of production cost?

1.4 Goals and Objectives:

The main goal is utilizing the resulting liquid effluent of anaerobic digester

1. To characterize the main composition of the digester effluent.
2. To know the effect of digester manure on physical and chemical properties of Soil.
3. To evaluate the suitability of the effluent as a fertilizer for different types of vegetables.
4. To evaluate the economic value of the effluent as an alternative to other bio fertilizer available in the market.

1.5 Significance of Study

Cow dung is an elementary source of plant nutrients and has been used as fertilizer for a long time. Recently it got higher value for the production of bio-methane using the anaerobic digester. Anaerobic digestion of cow dung manufactures a liquid effluent which retains the N, P, and K fertilizer nutrients of the raw cow dung. Digestion decrease pathogen counts and denatures weed seeds in raw dung, and the odors of raw dung are greatly minimized in the effluent, thereby easing the storage, movement, and application of manure nutrients. [8] As a result, anaerobic digestion may raise the fertilizer value of raw manure and could potentially decrease the need for synthetic nitrogenous fertilizers and decrease the energy applied in the production process.

1.6 Methodology

1. A collection of liquid effluent samples**.**
2. Make analysis &tests needed.
3. Purchase of seeds and research materials.
4. Set up greenhouse& soil test.
5. Planting the seeds (vegetable).
6. Monitoring the vegetable growth.
7. Examine and compare product quality.
8. Comparison of the vegetable growth using other bio fertilizers.

1.7 Budget

The total estimated cost for implementing this project is estimated at 984 $.

Table (1.1): The total estimated cost for implementing the project

NO	Item	Quantity	Cost
1	Transportation	-	100 $
2	Seedlings, agricultural	6	18 $
3	Greenhouses	2	80 $
4	Basins inside the greenhouse	2	192 $
5	Industrial soil	1 Kg	24 $
6	Pipeline watering	2	100 $
7	Tests of water	4	250 $
8	Soil test		90 $
9	Product test (fruit)		130$

1.8 Plan of Action

The action plan for this study during the first semester is shown in Table (1.2)

Table (1. 1): Plan of action for the first semester.

Date / Task	1st Month				2nd Month				3rd Month				4th Month			
	Wk_1	Wk_2	Wk_3	Wk_4	Wk_1	Wk_2	Wk_3	Wk_4	Wk_1	Wk_2	Wk_3	Wk_4	Wk_1	Wk_2	Wk_3	Wk_4
Identification of Project	■	■														
Literature Review			■	■	■	■	■	■								
Data collection					■	■	■	■	■	■	■	■				
Research Analysis & equipment							■	■	■	■	■	■	■	■		
Research crops will be planted							■	■	■	■	■	■	■	■		
Future research													■	■		
Presentation First Semester																■

Table (1. 2): Plan of action for the next semester.

TASKS	1st Month				2nd Month				3rd Month				4th Month			
	Wk_1	Wk 2	Wk 3	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4
Collection the sample& Make analysis for it																
Choose suitable land for planting																
Set up tunnels & planting seeds																
Monitoring the vegetables grow																
Examine and compare product quality																
Presentation of the second Semester																

CHAPTER TWO

LITERATURE REVIEW

2. Introduction

The digestion process generates a product called “biogas” that is primarily composed of methane, carbon dioxide, and compost products suitable as soil conditioners on farmlands Anaerobic digestion can be seen as a method to treat the organic wastes,as shown in the figure (2.1)[10]. The nature of digester may depend on the type of feed stock used for anaerobic digestion and digestion conditions (temperature retention time, PH, stage). Therefore, the results produced need verification on plant growth and treatment depending on the characteristics of digester, Liquid effluent from anaerobic digestion after microbial reactions has high levels of BOD (biological oxygen demand), COD (chemical oxygen demand), SS (suspended solids); low in DO (dissolved oxygen) and rich in nutrients the digester liquid effluent; the liquid fraction is rich in nutrients (N, P and K), approximately half of the N is in organic form; the other half is mineral (i.e. ammonium, NH_4). During anaerobic digestion, all nutrients including nitrogen remain in the reactor. Hence, in contrast to composting, no nitrogen is lost during anaerobic digestion [11] .

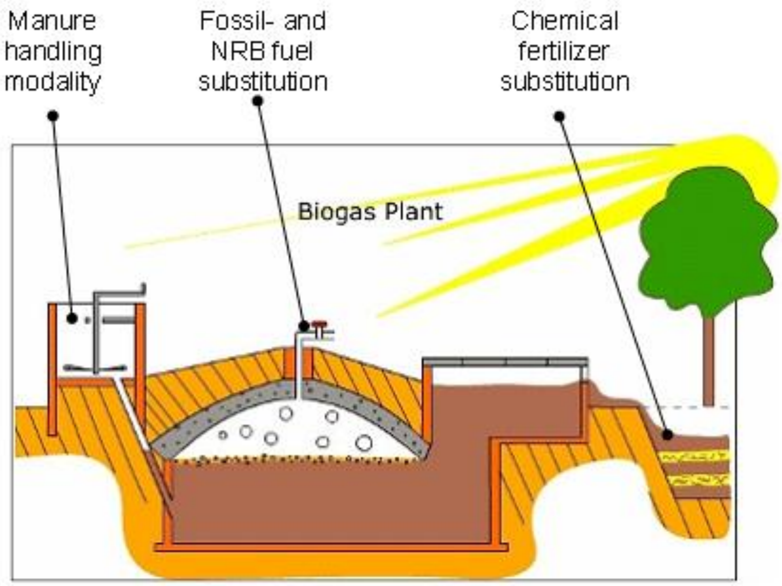


Figure (2.1): Digester plan.

The cattle slurry released amounts of nutrients, that produced by biogas plant. For example in assumed amounts (100 Mg fresh matter) about 80158 (Mg) of N,12303 (Mg) of P, and 77361 (Mg) of K.[12]

Digestion reduces pathogen counts and denatures weed seeds in raw dung, and the odors of raw dung are greatly reduced in the effluent, thereby easing the storage, movement, and application of manure nutrients.

The huge benefit of the anaerobic digested in the improvement of soil fertility and crop production, the safety of the digested, measured by the concentration of pathogens present, The availability of liquid bio fertilizer in the market is on the increase as one of the alternatives to chemical fertilizer and pesticides, one of its benefits is in the population of microorganisms present [13].

2.1 Overview early research on anaerobic digestion

Historical evidence indicates that the anaerobic digestion (AD) process is one of the oldest technologies. However, the industrialization of AD began in 1859 with the first Digestion plant in Bombay. By 1895, biogas was recovered from a sewage treatment facility and used to fuel street lamps in Exeter, England. Research led by Bus well and others in the 1930s identified anaerobic bacteria and the conditions that promote methane production.

As the understanding of the AD process and its benefits improved more sophisticated equipment and operational techniques emerged. The result was the used of closed tank and heating and mixing systems to optimize AD. Regardless of improvements, AD suffered from the development of aerobic treatment and low costs of coal or petroleum. While AD was used only for the treatment of wastewater sludge digestion, developing countries such as India and China embraced the technology. Small- scale AD systems were mostly used for energy and sanitation purposes. Numerous failures were reported. Nevertheless, technical improvements and increasing energy prices have led to a diversification of the waste treated and larger size AD plants.

In recent times, European countries have come under pressure to explore AD Market for two significant reasons: higher energy prices and increasingly stringent Environmental regulations.

AD facilities usually have a good record in treating a wide spectrum of waste streams such as municipal, agricultural or industrial waste. Some facilities have been in operation for over 20 years. More than 600 farm-scale digesters operate in Europe, where the key factor is simplicity. In addition to farm-scale digesters, Europe leads in large centralized AD systems[10].

2.2 Research on manure value of slurry

In 1959, many researchers emphasized compost produced by anaerobic decomposition more effective in maintaining nitrogen from the aerobic decomposition.

In 1961, the study showed that fertilizer which was obtained contain nitrogen by 1.7% in the dry matter also has a good effect on crops.

The experiments showed that the compost resulting from the process of anaerobic decomposition gave higher returns from the use of manure directly.

In Germany after the application is for a period of four or five years of this fertilizer on sugar crop, so that gave positive results. The result was obtained that no loss of nitrogen, along with good gas production.

The experiments also found that compost has good values and produces a good effect on crops such as potatoes, vegetables and tomatoes.To get a good quality fertilizer without nitrogen loss in addition to a good gas production, experimenters recommended that the proportion of the organic material to be approximately 30% of the organic matter or 22.5 percent of the dry matter [14].

2.3 Contemporary research on nutrient constitution of biogas slurry

Through the process of Anaerobic digestion technically for a variety of organic materials is evident biogas. In India and China a human and animal fecal matter in put most commonly used for the production of biogas. During the process Anaerobic digestion are converted from 25 to 30% of the organic material and originating in fecal matter s is converted into a gas that is vital and the rest in the form of fertilizer, this fertilizer containing nutrients for basic plants which are known (NPK) as well as other nutrients such as zinc, iron, manganese and copper which usually what they are available to the soil[15].

Nitrogen fertilizer is consumed in larger quantity.Because of the source of organic waste and the remnants of his A great importance in agriculture. In India through Anaerobic digestion process, about 51% of the total nitrogen in the form of ammonia and the remainder of the ammonia formed was digested.The other group results from experience that measure the formation of ammonia during anaerobic fermentation process for manure slurry. The experiment showed that the process of decomposition of manure contains 12 to 18 percent of the total nitrogen in the form of ammonia. The results showed that conducted the slurry that the value of PH ranging from 8 to 8.4.

According to a study in 1961, when he was drying cow dung through the process of anaerobic fermentation escaped about 96 percent of the ammonia dissolved in the air. To illustrate this loss was measured PH before and after the anaerobic fermentation process so that they7.2 ,8.3 respectively. This was the increase in alkaline due to the accumulation of ammonia in the slurry after digestion.The reason for this loss due to volatilization of ammonia through evaporation and drying during the digestion process. Dried residue containing nitrogen only 1.78, if there is no loss of nitrogen, the total nitrogen approximately 2.16 % dry matter [15].

Table (2. 1): Total solid content (dry matter) of fermentation materials commonly used in rural areas (approximation) digestion.

We can explanation large quantities of water leaving the digester**.**

Materials	Dry matter content (%)	Water content (%)
Dry rice straw	83	17
Dry wheat straw	82	18
Maize stem	80	20
Green grass	24	76
Human excrement	20	80
Cow Dung	17	83
Human urine	0.4	99.6
Cow urine	0.6	99.4

Source: APRBRTC, 1983:46

2.4 NPK values of fresh cow dung slurry

Table (2.2): NPK values of fresh cow dung slurry.

N%	P2O5%	K2O%	Author
1.00-1.80 (1-4)	0.8-1.2 (2)	0.8-1.00 (0.9)	Gupta, 1991
1.5-2.0 (1.75)	1.0	1.0	Tripathi, 1993
1.30	0.82	1.07	Gupta, 1991
1.25-1.30 (1.28)	-	-	Chowla, 1986
1.51	-	-	Naear. 1975 in Kuppuswamy, 1993
1.8-1.9 (1.85)	-	-	Acharya, 1961
1.4-1.8 (1.6)	1.1-2.0 (1.55)	0.8-1.2 (D)	Gitanjali et al. in Gupta 1991.
1.30-2.50 (1.9)	0.90-1.90 (1)		Myles et al., 1993
1.4-1.8 (1.6)	1.0-2.0 (1.5)	0.8-1.2 (t.0)	DOST, Govt of India, 1981
1.5-2.0 (1.75)	1.0	1.0	Khandelwal et al., 1986
0.5-1.0 (0.75)	0.5-0.8 0.65	1.5 (!.05)	Demont et al, 1990

2.5 Nutrient values of bio slurry

Plants need nutrients for growth, from these nutrients nitrogen which is one of the most important nutrients, plants need it in large quantities to reach the highest production, but it must be in balance with other nutritional elements. Lack of nitrogen or excessive use can reduce the quality of the crop, or even could damage crops. On the whole, nitrogen is added through chemical fertilizers.

After all, it has shown bio slurry to be a promising alternative to chemical fertilizer. Bioslurry meets the nutrients necessary for the plant, and this can increase crop and soil characteristics in general production .The fresh bioslurry can be low in nutrients while the carbon/nitrogen ratio can be low in sundried bioslurry and high in fresh bio slurry. Solid and liquid forms have different nutrient compositions.

Bioslurry varies from one study to another in the composition of nutrients. It always depends on the original substrate, the type of digester and the anaerobic process. However, we can state here is that bioslurry is not only rich in mineral and organic dry matter, but also in nutrients like N, P, K, CA, Mg, Fe, MN, organic matter, different amino acids and metals like copper and zinc. There seems to be a good match between soil N supply and plant N demand of liquid bioslurry.[1]

Figure (2.2): Pumpkin in Ethiopia treated with bio slurry [1].

2.6 Comparative of effects of chemical fertilizer and biogas slurry and chemical fertilizer on various crops

Phytonutrients are considered essential ingredient of sustainable agriculture components. The increase in agricultural production depends largely on the type of fertilizer used. Nature of nutrients and their characteristics are different from chemical fertilizers and bio fertilizer. Each type of fertilizer has its advantages and disadvantages with respect to the growth of crops and soil fertility.

The main advantage of bio-fertilizer is that it does not pollute the soil, also does not show any negative effect on environment and human health. This can be overcome either by adding chemical fertilizers containing nitrogen only for plants which are chemical treated or add other nutrients such as potassium and phosphorus to plant inoculated with bacteria. obtaining fewer amounts of healthy products with less environmental disturbances is preferred over obtaining a higher amount of non-healthy products with an environmental disturbances[15].

The advantages of using chemical fertilizers:

1. The effect is a direct and fast, to the availability of nutrients directly and soluble.
2. The price is relatively low, making it more acceptable and commonly used.
3. Containing a large amount of Phytonutrients [15].

The disadvantages of using chemical fertilizers:

1. Reduce the cohesion of plant roots with soil and prevent nitrogen-fixing symbiotic to the presence of a high percentage of nitrogen.
2. Used it excessively gives negative effects such as leaching and contamination of water sources and low soil fertility and thus causing the destruction of the whole system.
3. Excess supply of nitrogen works to soften the tissues of plants and thus makes them more susceptible to diseases and pests
4. It leads to the deterioration of soil structure because it promotes the decomposition of soil micro-organisms.
5. It reduces fertilizer efficiency due to the loss of nitrogen easily[15].

Biofertilizers differ from chemical fertilizer because they do not provide crops of nutrients directly, and are a culture of special bacteria and fungi types. The production technology of bio-fertilizer is relatively simple and the cost of installation is very low compared with chemical fertilizer plants.

Table (2.3): Effect of bio fertilizer and chemical fertilizer on the growth of lettuce (Young et al. 2003)

Treatment	Relative fresh weight (%) R	Relative dry weight (%)
CK (water)	55	67
½ CF†	67	83
½ CF + bio fertilizer	111	125
CF	100	100
Bio fertilizer	75	110

†Chemical fertilizer. Bio fertilizer: Combination of Bacillus sp. B. subtitles, R. erythropoies is B. pupils and P. rabiacearum

Advantages of biofertilizers:

1) They help to get a high yield of crops by making the soil rich with nutrients and useful microorganisms necessary for the growth of the plants.

2) Biofertilizers have replaced the chemical fertilizers as chemical fertilizers are not beneficial for the plants. They decrease the growth of the plants and make the environment polluted by releasing harmful chemicals.

3) Plant growth can be increased if bio fertilizers are used because they contain natural components which do not harm the plants but do the vice versa.

4) If the soil will be free of chemicals, it will retain its fertility which will be beneficial for the plants as well as the environment, because plants will be protected from getting any diseases and environment will be free of pollutants.

5) Biofertilizers destroy those harmful components from the soil which cause diseases in the plants. Plants can also be protected against drought and other strict conditions by using bio fertilizers.

6) Biofertilizers are not costly and even poor farmers can make use of them, they are environment friendly and protect the environment against pollutants.

As a result of the good structure provided to the soil, root growth is promoted[16].

2.7 Effect of digester manure on physical and chemical properties of Soil

Digester manures effect more positive in soil fertility, physical and chemical properties as shown in the table:

Table (2.4): Effect of digester manure on physical and chemical properties of Soil

LOCATION	TREATMENT	PH	Organic matter %	Total nitrogen %	Total (p_2o_5)	Available (p2o) ppm	Volume wlgm/c3	Porosity (%)
1-chyu (2)county years	1. check	6.85	1.040	0.064	0.096	13.2	1.44	45.66
	2. digester Sludge		1.210	0.068	0.110	14.4	1.41	46.59
	3.increase	6.80	0.17%	0.004%	0.014%	1.2	-0.03	0.93%
Dayi-County (1 y<<r)	1. check	8.30	1.035	0.071	0.109	16.3	1.27	52.59
	2. digester Sludge		1.286	0.101	0.110	0.04	1.16	57.35
	3.increase	8.35	0.25%	0.03%	0.001%	4.1*	-0.11	4.76%

Source: APRBRTC, 1983:160 *The increased ppm should have been-16.24 which mean that the available P_2O_5 was reduced with the application of digester sludge in this location. The report is, however, a preliminary one.

2.8 Organic matter and plant nutrients

Organic material is the main source of nutrients. Despite the presence of nutrients in small amounts, but the organic materials have a significant effect on the physical and chemical properties of the soil. When the decomposition of organic substances, nutrients released in the form of plants and crops can be absorbed it. It also helps the cohesion of the soil particles and improves water storage capacity. It is also responsible for the physical and environmental stability of the soil.

When adding nutrients to the soil is exposed to a complex series of biochemical steps leading to analyze it completely. Part of this nutrient exposed to oxidation during combustion processes. Energy is released in the process, which is used by bacteria and other microorganisms in the soil.

Decomposition of organic materials depends on the type of soil and site conditions. There are several factors that affect the rate of decay, including PH, temperature and water content, and the availability of nutrients and oxygen degree of micro-organisms in the soil[14].

2.9 Examples of some plants used

1. **Silver beet**

The effluent required to obtain better plant growth. A small-scale hydroponic system was constructed in glasshouse to test different concentrations of anaerobic effluent against a commercial hydroponic medium silver beet was negatively affected at 50% concentration due to low DO and NH4-toxicity. The concentration of 20% anaerobic liquid was found to be the most efficient with highest foliage yield and plant growth.

The hydroponic system with 20% concentrated effluent had better utilization of nutrients for plant growth and a COD reduction of 95% was achieved during the 50 days growth , This preliminary evaluation revealed that the growth and development of silver beet was significantly lower in anaerobic effluent compared to a commercial hydroponic plant growth solution[2].

Result:

There was effective COD reduction (86–97%) during hydroponic treatment of anaerobic effluent The EC of initial effluent was the highest in 30% effluent (2.31 ds/m). From the results it is clear that the growth of silver beet was not comparable with control medium due to inadequate uptake of nutrients to the plants[2] The results suggest that dilution of anaerobic effluent is necessary for irrigation purposes with anaerobic effluent especially in hydroponic system.

2. **Lettuce**

Leaf lettuce, of the cultivar Black Seeded Simpson, was selected for this study because of its short maturity period and ability to grow successfully in hydroponics systems .Lettuce seedlings were produced in plug trays that were filled with potting soil. A single seed was placed into each plug.

Watering of the seeds was done manually at a frequency that ensured that the trays were moist all the time. Once the seeds had germinated the amount of water was increased to ensure that the trays were always wet. It took two weeks for the seedlings to reach transplanting stage.[3]

Characteristics of nutrient solution: Nitrate-N (mg/L) = 355, Roth-P (mg PO43-/L) = 2... pH = 8.1The ATAD effluent was able to produce a vigorous crop of lettuce whose yield was calculated to be 70 – 75 percent of the control crop but due to high ammonia concentration which have a toxic effect on most crops. The ability of the ATAD effluent supports the recommendation for nitrification to improve the quality of the anaerobic digester effluent prior to use as nutrient solution for hydroponics systems.[3]

Another research focused on using effluent from anaerobic digestion (poultry litter) as an alternative fertilizer. In trials, lettuce three levels of effluent were chosen based on nitrogen levels as compared to a commercial fertilizer. Hydroponic solutions were monitored on a daily basis to maintain a pH of 5.5-6.1 .

Lettuce grown in the lowest effluent concentration grew at a steady rate after week 2, while the commercially fertilized lettuce grew slowly until week 4. Effluent from thermophile anaerobic digestion shows promise as an alternative fertilizer for hydroponics[5].

3. **Tomato**

Anaerobic digestion of tomato culls produces renewable energy (biogas) and a nutrient-rich effluent. Using the effluent from an anaerobic digester to grow tomato plants could offset the cost of synthetic fertilizer. Effluent from an anaerobic digester fed organic waste was analyzed for major plant nutrients and used as a nutrient medium to grow tomatoes

It is need a substantial amount of nitrogen in order to yield a tomato crop. A large amount of phosphorus is also needed for tomato growth. An outdoor crop of tomatoes requires 100-150 kg/ha nitrogen (N) and 20-40 kg/ha of phosphorus (P), while a greenhouse crop of tomatoes requires 200-600kg/ha N and 100-200 kg/ha P [4].

Result :

Tomato can growth by used anaerobic digester effluent, but this growth is limited .This is due to the high ammonia content of the effluent and tomato sensitivity to the ammonia.

The ammonia concentration must be measured for each batch. Once this is completed, the ammonia in the effluent must be nitrified, **further research** should focus on the nitrification process by using large-scale aeration over longer time periods or nitrifying bacteria. Additionally, characterizing other nutrients in effluent, such as phosphorus and potassium, could lead to a better understanding of the effluent and its potential as a fertilizer[4].

When using bioslurry

4. **Cucumber**

Cucumber productivity increases by 50% over control with a slurry application of 15 t/ha. More than 15 t/ha had a smaller cucumber yield increase. Resistance to wilt disease can also increase. The survival rate can increase and the fruit is of better quality. The crops can also become more resistant to pests and diseases and the soils become crumbly [1].

5. Other examples:

Use The effluent from an anaerobic biogas digester as a fertilizer for supporting crop growth Comparisons were made with an inorganic fertilizer and a water-only treatment, using three crops (maize, oats, and kale)[17]. ,the effluent was slightly alkaline, with a mean PH value of 8.0 (± 0.1 SD)
Total solids content averaged 2.5 ± 0.6%. Values of **other properties are shown in Table.**

Table (2. 5): Values of other properties [17].

	Composition per day Weight solid material		
Property	**Effluent**	**Soil**	**Annual addition to Soil in effluent**
Total C(%)	42.4	4.5 ± 0.3	0.08
Total N(%)	2.78	0.40 ± 0.02	0.005
Bacteria (10%)	13.5	11.6 ±4.7	0.05
Enzyme activity			
Urease	670 ± 1020	540 ± 270	1.3 ±2.0
Sulphatase	430 ± 620	220 ±44	0.8 ±1.2
Phosphatase	1540 ± 1590	2420 ± 170	3.0 ±3.1
Cellulose	1010 ± 450	27 ± 4	1.9 ±0.9
Invertase	7400 ± 5530	1050 ± 200	14.3 ±10.7
Amylase	1580 ± 1010	131 ± 14	3.1 ±2.0

Also, was found in green house >35% of tomato received>1000Kg nitrogen from organic and inorganic sources.
Green house sweet pepper and eggplant removed more nutrients in open fields because of higher yields.

Average nutrient balances calculated by subtracting crop off takes from fertilizer inputs for selected vegetable crop species of surveyed farms in the Beijing suburbs (Open fields)[18].

Result:

Crops receiving effluent or fertilizer were taller, leafier, and a darker green color than those receiving water only.
Crop dry matter yields usually did not differ significantly between effluent, inorganic fertilizer or water-only treatments, and the suitability of biogas digester effluent as a fertilizer could therefore not be determined by this criterion. Effluent applications did, however, increase the amount of plant-available N, with plant-N contents at the last harvest being higher than in the water-only treatment, Effluent applications maintained soil biochemical properties at levels that were at least as high as those found in the water-only and inorganic fertilizer treatments. Several indices of soil available- N were highest in the effluent treatment. No adverse effects of the effluent on plant or soil proper ties were observed [18].

Table (2.6) Average nutrient balances [18].

Species	Nitrogen kg ha^{-1}	Phosphorus kg ha^{-1}	Potassium kg ha^{-1}
Cabbage	529	169	159
Cucumber	699	238	58
Tomato	611	227	25
Sweet pepper	639	307	47
Eggplant	619	347	41

CHAPTER THREE

Research methodology

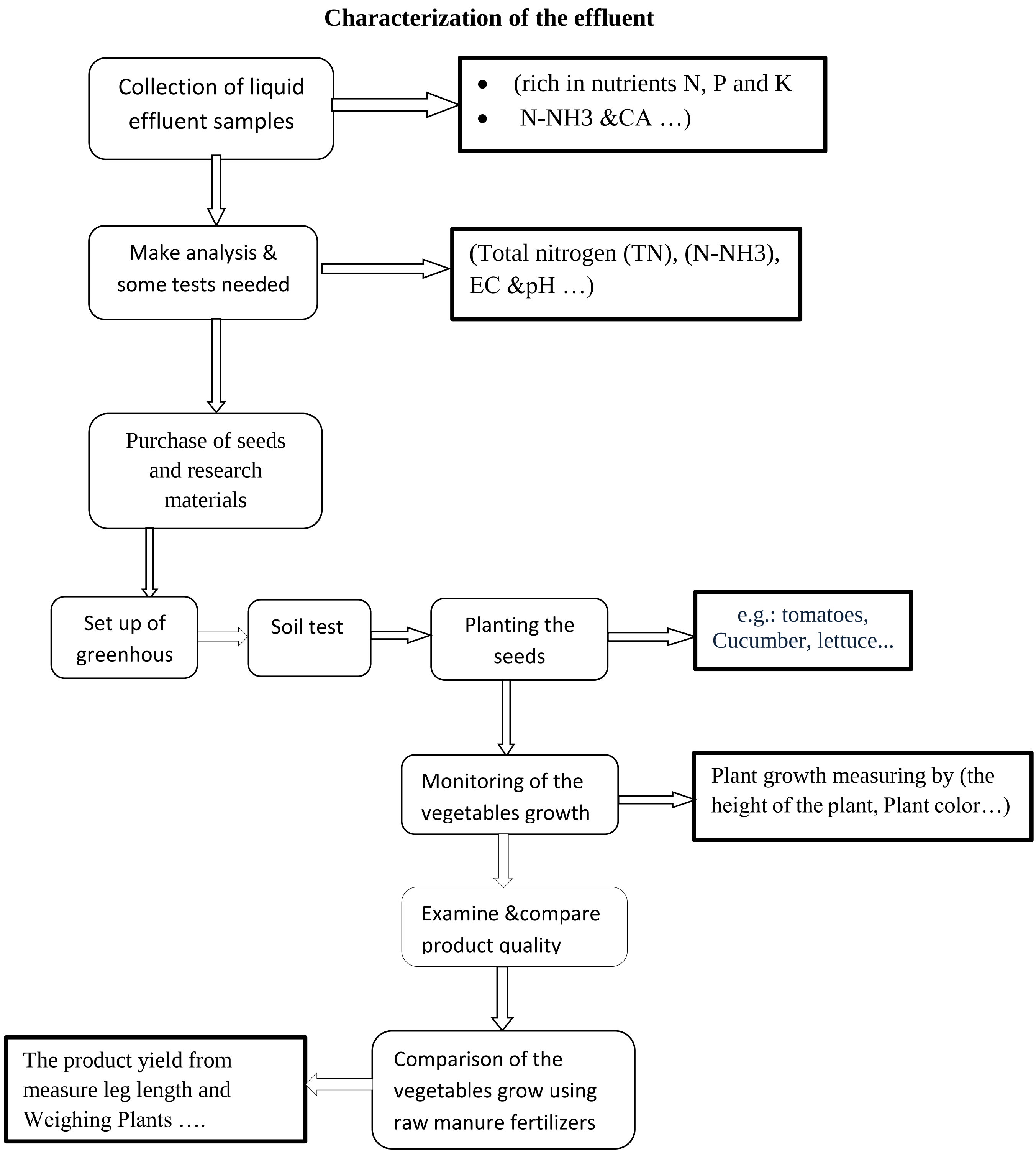
3. Introduction

At the beginning research in the subject and but the aim , find and collect information from previous studies or question people involved and they have to know about this study, such as , Engineer, teachers, farmers. Then made a plan for the project. At the beginning will be taken a sample from the digester in the al- Jebreni farm. Then the work of analysis will need in the laboratory, then selecting plants that will be planting, that's dependence on several of rules, and set up tunnels to grow plants in it , then monitor the growth and finally the product will compared with other products to shown the results.

In this figure the place where the project of anaerobic digesters, in Algebra farm in the Al-Dahriah – Hebron that will take the sample from it.

Figure (3.1): Al-Jebreni farm.

3.1Flow chart methodology



3.2 Overview of the al-Jebreni plant (biogas plant).

The biogas plant produces biogas from biomass (organic waste) through Anaerobic Digestion, This process generates biogas and bio-fertilizer (digestion), and the biogas plant will transform the biogas through a Combined Heat and Power unit into thermal energy (heat) and (green) electricity.

Figure (3.2): B**iogas plant.**

Description of the biogas plant:

The raw materials were input in manure tank is the Animal excrements (Cow Manure, Residues from agricultural, (Straw mixed with the manure), and Food production (Dairy plant waste and whey).

The Products from biogas plant has three different products – electricity and heat (renewable energy) and bio fertilizer.

The Storage of tank volume that is equal 6000 m3 , (90% liquid & 10% solid) , the output 68 ton liquid and 6 ton solid in day , and the total of Liquid fraction is 9500 m3 & Solid fraction is 3500 ton , a Cow manure solid digester that Contains : NPK (1.6-1.4-1.7+1.5CaO),PH:7.5-8.5,C/N:10.

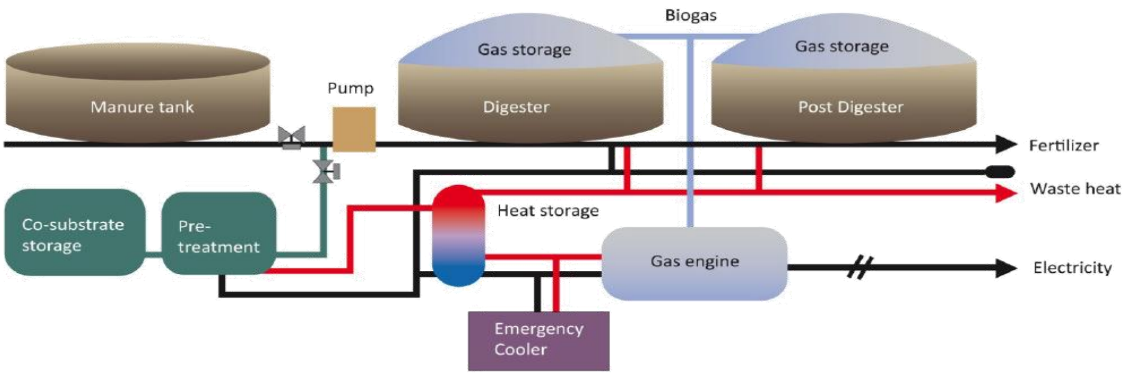


Figure (3.3): The biogas plant description.

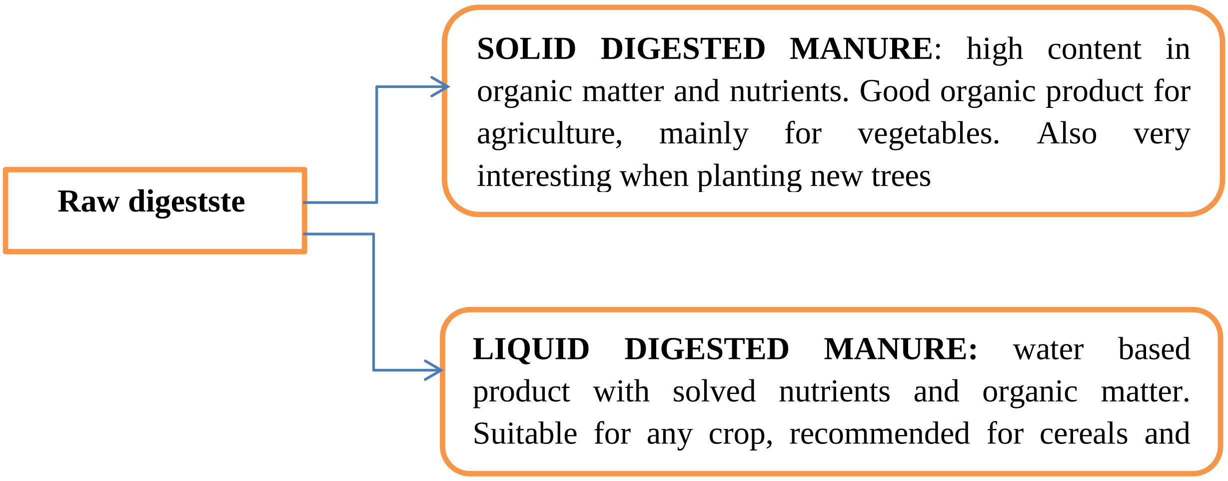


Figure (3.4): Type of raw digestate.

3.3Experimental part

Collection the samples: A representative water sample is collected in a glass or polyethylene bottle, which should be properly washed/rinsed with the same water that is being sampled.

3.3.1 Analysis of the sample (liquid discharge from digester)

Characteristics of the sample (Measure liquid content of):

- N, P and K
- N-NH3.
- N-NO3.
- BOD &COD.
- Zn ,Mn, Mg , Na, B, Cu, Fe, & Cl.

3.3.2 Materials and Equipment

- **The analysis needed[19] :**

1. Total suspended solid (TSS).
2. Total dissolved solid (TDS).
3. Suspended solid (SS).
4. Nitrogen (N).
5. Ammonia (N-NH3).
6. Phosphorus (P).

7. Potassium (K).
8. Electrical conductivity (EC).
9. PH.
10. COD & BOD.
11. Moister connect (MC).
12. Iron (Fe).
13. Zinc (Zn).
14. Copper (Cu).
15. Nitrate (NO3-).
16. Manganese (Mn).
17. Chloride (Cl-).

3.3.3 The aim of each test

- Salinity is characterized by **electrical conductivity(EC),** Because the ability of water to conduct electricity is directly related to the number of ions

The principal effect of salinity is restriction of soil water availability to the plant root system.

- Excess **Chloride** concentrations in soil solution have been shown to be Phytotoxic for certain crops.
- Important determinations are the chemical oxygen demand **(COD)** which gives the total organic substances, and the biochemical oxygen demand.
- Increase **K** in plant tissues, can lead to limited plant uptake of other required nutrients.
- **Nitrate (NO3 --N) ppm** High concentrations: succulent plant growth, tissues not as resource efficient, & plants more susceptible to some pests.
- **Total Dissolved Solid (TDS) ppm** the same as **total dissolved solids** in clear, non-turbid water. High salinity- salt accumulation in fine textured soils, hard for roots to absorb water.
- **PH**, Regulates plant nutrient & soil elements availability. Indicates a problem exists, continue to evaluate. Alkaline water: high in CO3 and HCO32- and/or salinity. Normal range: 6.5 – 8.0.
- **Chloride (Cl^-) ppm** Mobile in the soil. Cl- can be taken up by roots & accumulate in leaves causing toxicity
- **Iron (Fe^{2+} or Fe^{3+}) ppm** coatings form on leaf surfaces & may reduce photosynthesis. **Such as** Manganese **[20].**

Table (3. 1): Standard of the tests.

Test	Standard
pH	6-9
TDS (mg\l)	1500
TSS (mg\l)	50
COD (mg\l)	200
Chloride (Cl^-) (ppm)	400

Iron(Fe) (ppm)	5
Zinc(Zn) (ppm)	2
Copper(Cu) (ppm)	0.2
Manganese(Mn) (ppm)	0.2

Table (3.2): Materials and equipment used in tests[21].

Test	Materials	Equipment
DETERMINATION OF IRON	• Hydrochloric acid • Hydroxylamine solution • Ammonium acetate buffer solution • Sodium acetate solution • Stock iron solution • Standard iron solution	• Spectrophotometer. • Kessler tubes. • Glassware.
DETERMINATION OF MANGANESE	• Special reagent • Ammonium per-sulfate • Standard manganese solution • Hydrogen peroxide 30%	• Spectrophotometer. • Nessler tubes. Glassware like conical flasks.
BOD test	• Distilled water • Phosphate buffer solution • Magnesium sulfate solution • Calcium chloride solution • Ferric chloride solution • Acid and alkali solution • Seeding • Sodium sulfite solution • Reagents required for the determination of D.O.	• B.O.D. bottles. • B.O.D. incubator • Burette. • Pipette • Air compressor Measuring cylinder
Chemical Oxygen Demand (C.O.D.)	• Standard potassium dichromate solution 0.25N • 2.Sulphuric acid reagent • Standard ferrous ammonium sulfate • Ferron indicator solution • Mercuric sulfate • 6.SulPHuric acid crystals	• Reflux apparatus. • Burettes. • Pipettes
DETERMINATION OF CHLORIDE	• Chloride free distilled water • Standard silver nitrate solution (0.0141N) • Potassium chromate indicator • Acid or alkali for adjusting PH	• Burette • Pipettes. • Erlenmeyer flasks. • Measuring cylinder.

DETERMINATION OF PH	• Buffer solutions • PH paper • Universal indicator	• PH meter with electrode. • Beaker. • Thermometer • Color comparator with discs • Cuvettes
DETERMINATION OF SOLIDS		• Porcelain evaporating dishes. • Steam bath. • Drying oven. • Desiccators
NITRATE NITROGEN	• Stock nitrate solution • Standard nitrate solution • Sodium arsenite solution • Brucine-sulfanilic acid solution • Sulfuric acid solution • Sodium chloride solution	• Spectrophotometer. • Water bath. • Reaction tubes Cool water bath

3.4.1 Set up the tunnel and Soil test

Will be Chosen a suitable location for agriculture and Take into consideration provide all suitable condition for plant growth, such as climate, soil and available necessary equipment will need.

Experimental design will be made , taking in the account number , type of crops and the distance between them , the network consists of three row , one that will be used the cow manure for planting , two that will be used the liquid digester and three is control (normal) , that will be used fresh water from dripper capacity was 1.6 L/hour for irrigated three row with regard to soil will be make tests needed for soil , such as the level of salts, (pH.) , measurement of conductivity(EC) and measure the temperature of soil .

3.4.1.1 Soil test:

Soil sampling and laboratory analysis: Soil samples will be collected at random from 15-25 cm depth from the study site and bulked, the sample will take for laboratory analysis to determine the physical and chemical properties.

- **pH**

Soil PH measurement is useful because it is a predictor of various chemical activities within the soil. As such, it is also a useful tool in making management decisions concerning the type of plants suitable for the location, the possible need to modify soil pH (either up or down), and a rough indicator of the plant availability of nutrients in the soil. Soil pH directly affects the solubility of many of the nutrients in the soil needed for proper plant growth and development.

- **Electrical Conductivity**

The Electrical Conductivity (EC) of a solution is a measure of the ability of the solution to conduct electricity. The EC indicates the presence or absence of salts, when ions (salts) are present, the EC of the solution increases. If no salts are present, then the EC is low indicating that the solution does not conduct electricity well. The EC indicates the presence or absence of salts, the soil has a little direct detrimental effect on sandy minerals oils or on media. However, EC directly affects plants growing in the soil or media. The impact of EC on plants is also directly affected by water management [25].

- **Soil Temperature**

Soil temperature that is effected on plant growth, the timing of budburst or leaf fall, the decomposition rate of organic material, and other biological, chemical, and physical processes that take place in the soil.

It is recommended that the temperature of the soil at the planting of 15 C degrees for planting cucumbers and squash, and will measured the temperature after planting to determine the amounts of irrigation daily and will be measured over the weeks [23].

3.4.2 Planting the seeds (vegetables)

Prefer apply the Liquid on seedlings, but because we want quick results, we will choose the short-life-cycle plants, there are several options according to studies:

We preferred to stay away from Leafy plants that are eaten fresh like lettuce , also can be plant tomatoes that is need about 60 days to grow and produce fruits.

Preferred to cultivation of cucumbers and squash because it needs short time from two weeks to 20 days of growth and produce fruits **So** we will choose more than one type initially we will cultivate squash and cucumbers and tomatoes.

3.4.3 Equipment will be used in planting:

1. Tunnels height of about 40 cm and the width of 1 meters
2. 15 seedlings will plant, 5 in each column.
3. Drip irrigation pipes length 3meters.
4. Plastic for cover the tunnels length 4meters.

3.4.4 Monitoring the growth

The plant grows to measure throw the height of the plant, Plant color, and the first node outcrop. Also for leaves: number, surface area (indicates a plant's physiological age) every 2-3 days and color of leaves[22].

3.4.5 Examine and compare between product for liquid and raw manure

First, Depending on the type of plant, the product yield from measure leg length and height, Weighing Plants, Root Mass measure the surface area of leaves, the distance between node & chlorophyll Content, also the number and size of the fruit.

Chapter Four

Tests analysis

4.1 Tests analyses

Based on what has been planning to in the first part of the project, it has been working in this part of several tests of liquid digester samples to ascertain the extent of the validity of this liquid for use as fertilizer for some crops without giving any negative consequences for human health. And it will explain in detail all the experience and analysis has been done on the liquid and give the results, and compare them with the permissible standards in agriculture.

1. pH test

Procedure:

1. Preparing for Calibration.
2. Calibrating PH Meter.
3. Using PH Meter.
4. Reading the value of PH.

Figure (4.1): Calibrating PH Meter

2. Electrical conductivity

Procedure:

1. Conversion device indicator of the injunction electrical conductivity.
2. Calibration of testing device by standard solutions of electrical connectivity.
3. Input electrode device in the form, and then record the reading from the device directly.

Figure (4.2): Conductivity meter.

3. Total Solid (TS)

Procedure:

1. Ignite the clean evaporating dishes in the muffle furnace for 30 minutes at 550°C and cool in a desiccator.
2. Note down the empty weight of the dish (W1).
3. Pour a measured portion (50 to 100 mL) of the well-mixed sample into the dish and evaporate the contents by placing the dish on a steam bath.
4. Transfer the dish to an oven maintained at either 103–105°C or 179–181°C and dry it for 1 hour.
5. Allow the dish to cool briefly in air before placing it, while still warm in a desiccator to complete cooling in a dry atmosphere.
6. Weigh the dish as soon as it has completely cooled (W_2).
7. Weight of residue = ($W_2 – W_1$) mg.

W_2 and W_1 should be expressed in mg.

4. Total suspended Solid (TDS)

Procedure:

1. Filter a measured portion of the mixed sample (50 or 100 ml) through a filter paper and collect the filtrate in a previously prepared and weighed evaporating dish.
2. Repeat the steps 3 to 6 outlined in total solids procedure.
3. Weight of dissolved solids = ($W_5 – W_4$) mg.

W_4 = Weight of empty evaporating dish in mg.

W_5 = Weight of empty evaporating dish in mg + Residue left after evaporating the filtrate in mg.

5. Total suspended solids

Procedure:

TSS = Total solids – Total dissolved solids

6. Chloride (Cl^-)

Procedure:

1. Transfer 10 ml of sample into beaker 250 ml.
2. Add 1 ml of Potassium dichromate ($K_2Cr_2O_7$).
3. The liquid after addition Potassium dichromate turns yellow.
4. Titrate with Silver Nitrate ($AgNO_3$).
5. The change color from yellow to brownish.

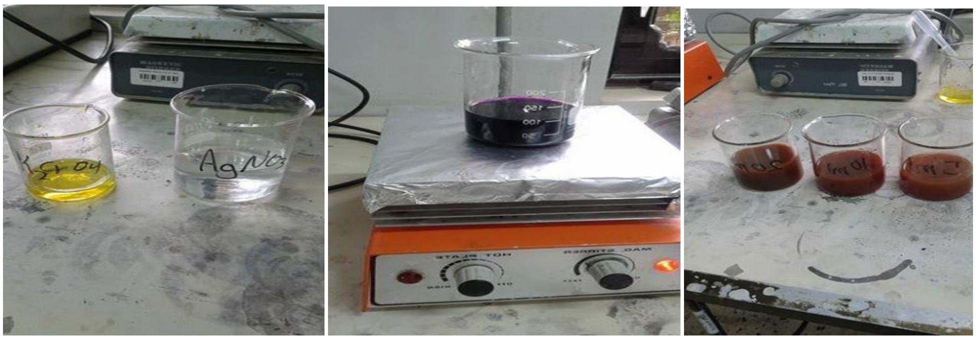


Figure (4.3): Chloride device.

7. Nitrate (NO^{-3})

Procedure:

1. Take of 10 ml of sample into a 50-mL conical flask, and put flask in cold water for a few minutes.
2. Add 1 ml 0.1% chromo tropic acid solution, drop by drop, directly in the Solution without mixing, and again put in cold water for few minutes to cool.
3. Mix solution, and add 6 ml concentrated sulfuric acid on the flask wall without mixing.
4. After adding acid in all samples, swirl flask and leave to cool at room Temperature; color (yellow) develops after 45 minutes.
5. Prepare a standard curve as follows:

- Pipette 3 ml of each standard (0.5 - 3.5 ppm), and proceed as for the samples.
- Read the absorbance of blank, standards, and samples after 45 minutes on spectrophotometer at 430-nm wavelength.

6. Prepare a calibration curve for standards, plotting absorbance against the respective NO_3-N concentrations.
7. Read NO_3-N concentration in the unknown samples from the calibration curve.

Figure (4.4): Nitrate device (spectrophotometer).

8. Potassium (K+), Manganese (Mn), Zinc (Zn), Copper (Cu), Iron (Fe)

Procedure:

1. Take of 50 ml from sample in beaker or flask.
2. Reading the standard and samples on spectrophotometer.

Figure (4.5): Potassium, zinc, manganese, cooper, iron device.

9. Nitrogen

Procedure:

A. Digestion:

1. Take by pipette 5 ml from sample in test tube.
2. Add about (2-3) g catalyst mixture, a few pumice boiling granules.
3. Add 10-ml concentrated sulfuric acid (in the fume hood).
4. Place the tubes rack in the block-digester, and slowly increase temperature setting to about 380°C. The H_2SO_4 should condense about half-way up the tube neck; and when solution clears, continue heating for about 2 hours.
5. Let tubes cool to 50-60 ^oC.
6. Transfer digests into the distillation tube quantitatively.

Figure (4.6): Nitrogen digestion.

B. Distillation:

1. Before distillation, shake the digestion tube to mix thoroughly its contents and then immediately placed a distillation tube.
2. Add 25-ml boric acid 4% in the Erlenmeyer flask 250-ml.
3. Add 50-ml distilled water.
4. Add 50-ml NaOH 35%.
5. Start distillation, and continue for 5 minutes.
6. After distillation, add 4-5 drop indicator solution.
7. Titration the distillate with standardized sulfuric acid (H_2SO_4) Solution, 0.05N.

a b c

Figure (4.7): Nitrogen distillation.

10. Phosphorus

Procedure:

1. Take of 10 ml of sample into a 50-ml volumetric flask.
2. Add 8 ml from reagents.
3. Complete to volume to 50-ml distilled water.
4. Read the absorbance of standards, and samples after 10 minutes at 720 nm wavelength.
5. Read the absorbance of blank, standards, and samples after 45 minutes on spectrophotometer at 720-nm wavelength.
6. Read P concentration in the unknown samples from the calibration curve.

11.COD test

Procedure:

1. Place 50ml sample in 500 ml refluxing flask (for samples with COD> 900mg/L use a smaller sample diluted to 50 ml).

2. Add 1g $HgSO_4$ and several glass beads.
3. Add slowly 5ml H_2SO_4 reagent while mixing to dissolve $HgSO_4$.
4. Cool while mixing to avoid the loss of volatile materials.
5. Add 25 ml 0.25N $K_2Cr_2O_7$ solution and mix.
6. Attach the flask to the condenser and turn on cooling water.
7. Add reaming H_2SO_4 (70ml) through open end of the condenser continue mixing while adding H_2SO_4
8. Reflux the mixture for 2 hrs. and cool to room temperature, after diluting the mixture to about twice its volume with distilled water
9. Titrate excess of $K_2Cr_2O_7$ with Ferrous ammonium sulfate using 2,3 drops of Ferro indicator. The end point will be from blue green to reddish brown
10. Reflux and titrate in the same manner a blank containing the reagents and the volume of the distilled water will be equal to that of sample. Chemical Oxygen Demand. [24]

COD values are obtained from the following mass balance equation:

$$\text{COD as mg/L} = \frac{(A-B)\times 8000\times M}{V_S}$$

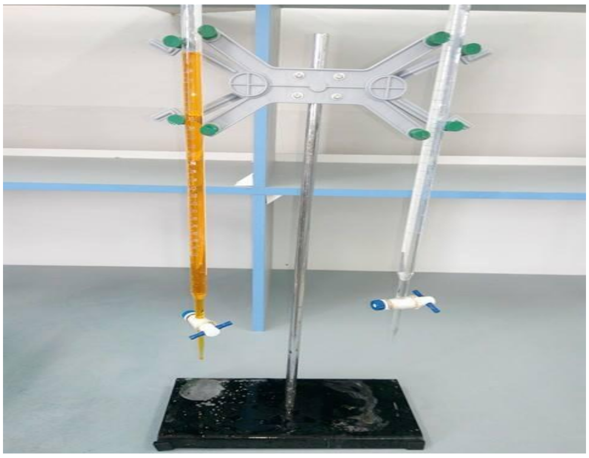


Figure (4.8): COD device

4.3 Soil Analysis

4.3.1 Determination of pH Soil

A soil analysis is a process by which elements such as P, K, Ca, Mg, Na, S, Mn, Cu and Zn are chemically extracted from the soil and measured for there "plant available" content within the soil sample.

The soil pH reflects whether a soil is acidic, neutral, basic or alkaline. The acidity, neutrality or alkalinity of a soil is measured in terms of hydrogen ion activity of the soil water system. The negative logarithm of the H ion activity is called pH and thus pH of a soil is a measure of only the intensity of activity and not the amount of the acid present. The pH range normally found in soils varies from 3 to 9.

Figure (4.9): pH of soil

Table (4. 2): Standard for Soil pH [23].

<5.0	5.5	6.0	6.5-7.5	7.5-8.5	>8.5
Strongly acid	Moderately acid	Slightly acid	Neutral	Moderately Alkaline	Strongly Alkaline
			Best range for most crop		

The soil pH, that it obtained within a range as show in the table (4.3), and it's suitable for a plant that it chosen.

Table (4.3): PH Requirements of Some of the Commonly Grown Vegetables [23].

4.5 – 6.0	5.5 – 7.5	6.0 – 7.0	6.0 – 7.5
 **Potato**	 **Pumpkin**  **Cucumber**  **Cauliflower**  **Tomato**	 **Onion**  **Lettuce**	 **Cabbage**  **Spinach**  **Beans**

Chapter Five

Stage and measurement of planting

5 .1 Selecting the plantation location

This study was conducted in Al-Dahriah city, Hebron governorate in the early cropping seasons of, middle of March 2017. Al-Dahriah city is located in the south eastern with annual rainfall in the range of 220 to 250 mm and means annual temperature of 17 to 35°C, the soil temperature at surrounding area was measured continuously over the days.

5.2 Experimental design for planting

A study was conducted in Al-Dahriah city, Hebron governorate to determine the effects of beef manure and tunnel mulching for optimum squash production , squash was chosen because that's crops which have a short life cycle and fast growth rate than other.

Experimental design and field layout: The trial was 3 treatments replicated 5 times each arranged in a randomized complete block design. Treatments included solid Manures, liquefied manure and control. The Plant spacing was 50X50 cm. An irrigation network was installed whereas every dripper capacity was 1.6 L/hour, as show in the figure:

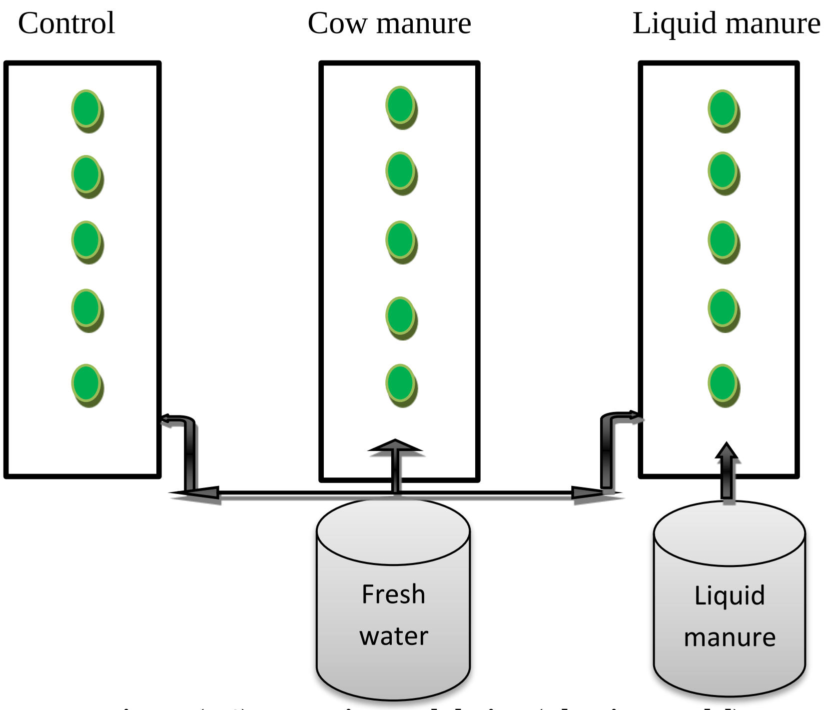


Figure (5.1): Experimental design (Planting model).

Tunnels height is about 40 cm, the width of 1 meters and the length is 3 m, as shown in the figure (5.2). Drip irrigation pipes length 3 meters and the length of plastic for cover the tunnels is about 4meters.

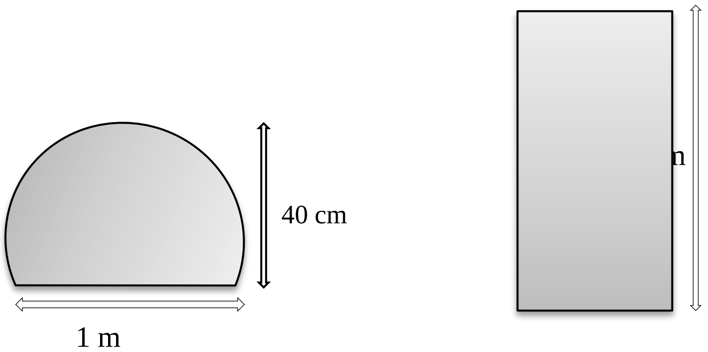


Figure (5.2): Longitudinal and cross section of the tunnel.

5.3 Planting stages:

At 16/3/2017

Seed was planted, the tunnels were constructed, the drip irrigation pipes were extende, and the tunnels were covered in plastic as show in figure (5.3)

The cow manure was put before planting and liquid manure was irrigated each sapling about 2 liters every 2 days.

(a) (b) (c) (d)

Figure (5.3): The steps of build tunnels and planting.

5.4 Measurement methods of growth

1. **The Width of plant :**

Figure(5.4): Width of squash plant in (8/4/2017) & (16/4/2017).

As shown in the table :

Table (5. 1): Measure Width of the plant (cm).

Date	Liquid digester	Cow manure	Control (normal)
8/4/2017	**Width of plant (cm)**		
	32-34	21-25	28-32
16/4/2017	80-90	60-75	75-85
23/4/2017	80-94	63-80	75-90

2. **The Number of leaves**

Figure(5.5): Number of leaves of squash in (8/4/2017) & (16/4/2017).

As shown in the table :

Table (5.2): Measure Number of leaves

Date	Liquid digester	Cow manure	Control (normal)
8/4/2017	**Number of leaves**		
	9-10	8-9	6-7
16/4/2017	14-18	10-14	10-15
23/4/2017	14-19	10-15	10-17

3. The hight of plant

Figure(5.6): High of squash plant in (8/4/2017) & (16/4/2017).

As show in the table:

Table (5.3): Measure Leg length (cm)

Date	Liquid digester	Cow manure	Control (normal)
8/4/2017	**Leg length (cm)**		
	16	12.5	13
16/4/2017	32-37	20-25	22-25
23/4/2017	37-41	23-25	30-37

4. The tempersture

Figure(5.7): The tempreture in (8/4/2017) & (16/4/2017).

As shown in the table :

Table (5. 4): Measure temperature.

Date	Liquid digester	Cow manure	Control (normal)
8/4/2017	**Temperature (C)**		
	38.7	44.3	39
22/4/2017	25	25	25

5. Width of leaves

As shown in the table :

Table (5.5): Measure Width of leave (cm)

Date	Liquid digester	Cow manure	Control (normal)
8/4/2017	**Width of leave (cm)**		
	10	8.5	9-10
16/4/2017	10-23	10-20	10-22
23/4/2017	17-27	12-25	12-25

6. First node out crop :

First node out the crop in a liquid digester in 20/4/2017, then note different in the number of node in each one, and the first nodes opened in liquid digester in 23/4/2017 as show in figure (5.8).

Figure (5.8): First node opened.

7. **Measuring quantity of the product :**

In 28/4/2017 the crops were begun produce fruit , first fruit out in liquid digester
As shown in the table (5.6) and the figures (5.9) :

Table(5.6): Number of nodes & fruits

Date	Liquid digester	Cow manure	Control (normal)
22/4/2017	**Number of nodes & fruits**		
	16	10	13
29/4/2017	20	14	16

a **b** **c**

Figure (5.9) : Start production squash fruit in crops(a is liquid digester , b is normal and c is cow manure (solid))

8. **Leaves color (indicates the amount of chlorophyll in the plant):**

Was observed differently in color for each leafs of plants, for example the control (normal) was light green, cow manure was dark green and liquid digester was Darker than other like natural color, this indicates that the percentage of chlorophyll is different in these crops, and the liquid digestion crops contain chlorophyll more than others.

9. **Measuring diameter of plants :**

A bout 10 cm higth of legth, caliber was used for measure

Table (5.7) diameter of plant(cm)

Date	Liquid digester	Cow manure	Control (normal)
10/4/2017	**Diameter of plant(cm)**		
	0.6-0.85	0.5-0.77	0.6-0.82
1/5/2017	1.52-2.9	1.26-2.4	1.27-2.41

CHAPTER Six

Result

6.1 Effects of the liquid digested manure:

Due to its characteristics and composition, the use of the liquid digested manure in agriculture will produce effects on plant and soil. First on plant, strengthen the roots, no phytotoxicity, better (quantity and quality) grain production and organic matter increase the plant resistance to plagues and weather conditions (draught, cold, high temperatures…).

On the soil, better soil retention of nutrients and vitamin nutrients not only for the plant, also for the soil ecosystem: bacteria, fungi and other benefactions microorganisms, as is mostly organic, it is not leaking and remains in upper layer available for the plant roots.

Liquid Digested manure (Biogas Plant) advantages affect nitrogen in mineral forms, low nitrogen losses by volatilization, high C/N relation, soluble organic matter, high content in Folic acids almost odorless and Composition stability.

Comparison with cow liquid manure, nitrogen (Urea), nitrogen is volatile, so it doesn't get fixed in the soil, not absorbable compounds low quality organic matter, odor and low stability.

6.2 Digester composition

Digested manure has higher ammonium NH_4^+-N: total N ratio and a narrow C: N ratio in simile with animal slurries, particularly when they derived from feedstock with a rise breakdown end/or a high N-content (e.g. cereal grains, poultry.)

The effects of AD processes on chemical characteristics of digestate are: reduce in the total and organic C contents, decrease of biological oxygen demands (BOD), higher pH values and more decreased viscosities than undigested animal manures. The pH rise is usually because of formation of ammonium carbonate ($(NH_4)_2CO_3$) and the elimination of CO_2, but sundry components impact digested manure reaction.

The liquid digested manure include less than 10 % of DM, while the solid digested manure generally comprise more than 15 % DM. The composition of treated digested manure often show a relationship between nutrients (i.e. N: P, N: K) not stable for the goal of plant nutrition.

Digester effect on soil nitrogen, rise of the rapid availability of N in comparison with animal manure is predictable due to high N in the NH_4^+ form applied with all types of digested manure.

NH_3 emission: digested manure has a higher fraction of NH_4^+-N and higher PH, which rise NH_3 volatilization potential. However, because of the decrease DM content, digested slurry can infiltrate faster into the soil decreasing potential NH_3 emissions after application to the soil in some conditions.

Effects of the solid digester compost due to its characteristics and composition the use of the compost in agriculture on the plans: high germination rate of the seeds as it has no phytotoxicity, strengthen the roots plant development and growth acceleration (nitrogen content), better (quantity and quality) fruit and grain production organic matter increase the plant resistance to plagues and weather conditions (draught, cold, high temperature).

On soil gives porosity to the soil, water retention, roots development No soil and water contamination as it has low humidity.

6.3 Test Results:

By conducting several liquid digestate and soil tests, the values shown in the table (6.1) were obtained:

Table (6.1): Results.

Test	Value
PH	7.3
TDS (mg\l)	30
TSS (mg\l)	10
SS (mg\l)	20
COD (mg\l)	-
Nitrogen (N)	0.252
Nitrate (NO_3^-) (ppm)	283.41
Chloride (Cl^-) (ppm)	420.00
Phosphorus (P) (ppm)	52.97
Potassium(K^+) (ppm)	98.31
Iron(Fe) (ppm)	16.48
Zinc(Zn) (ppm)	2.137
Copper(Cu) (ppm)	0.491

Manganese(Mn) (ppm)	0.905
Soil pH	7.96

Note: according to Palestinian Standards for Treated Wastewater the test have passed and in the range.

6.4 Dissection the results:

The results of the experiment indicated a positive response of the test crop to increasing levels of liquid digests, crops was irrigated with liquid digester growth faster than other (the number, high of plant, color, and width of leaves and plants..) in liquid digester more than another as shown in figure (6.10), and as shown the normal was better than cow manure, maybe that's because the cow manure is not suitable for planting squash and the solid need more time to absorbed by the soil. .

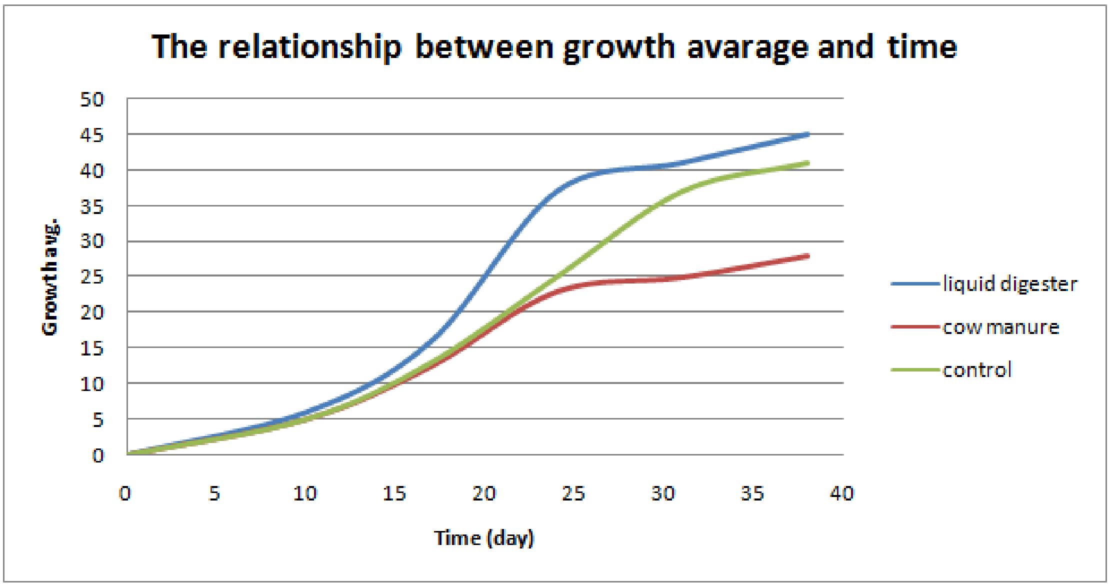


Figure (6.1): The relationship between growth average and time.

As for the temperature at the beginning in solid more than other about 45C inside the tunnel ,that's high Comparison of normal and liquid digester that's was about 39 C in liquid and 38 in normal, maybe that's effect on the growth in solid manure less than other . But after removing the plastic from on the plans the temperature was the same about 25 in each one.

Also the number and weight of fruit is better in the liquid digester. That's weight in liquid digester is 46gm, 35gm in cow manure 38gm in normal, as shown in the figure (6.2) the different between them is clear and the liquid digester is best .

Figure (6.2): Squash crops (Normal, cow manure and liquid digester).

Chapter Seven

Conclusion and recommendation

7.1 Conclusion:

In our study, liquid manure digested was used in the squash plant. This was chosen because the period of its life is short. So that the zucchini was grown in three ways: adding the cow manure (solid), liquid digested manure, normal (control). The difference was observed during the process of growth through studying several characteristics of the plant such as measuring the leg length so that the results were as follows: **37-41**, **23-25**, **30-37**, liquid digested manure, cow manure (solid), normal (control) respectively.

As for the number of leaves, the results were as follows: in liquid manure digested, cow manure (solid), normal, (control), **14-19**, **10-15**, **and 10-17** respectively. As for Measure Width of leave**: 17-27, 12-25, 12-25**respectively. As for Measure Width of the plant**: 80-94, 63-80, 75-90** respectively.

The results obtained in this study showed that the crops irrigated with this liquid have increased their rate of growth than normal, because it contains nutrients necessary for soil and plant and the speed of absorption in the soil relatively fast. As for the crops on which the cow dung was placed, their growth rate was slower than normal growth. This is because it takes a period to decompose and absorb it from the soil, thus adversely affecting the growth of crops.

7.2 Recommendation:

In view of the results of this research, these recommendations can be presented:

- The University adopts the establishment of a center for practical research and the provision of all sources of scientific research.
- The need to provide scientific laboratories necessary for the work of various agricultural tests and analyzes.
- Establishing a financial fund to support students in carrying out research and scientific experiments.
- The need for further scientific studies on this liquid and its validity in use as fertilizer on other types of vegetables and crops.
- The necessity of cooperation of the university with the Ministry of Agriculture to provide agricultural staff qualified scientifically and practically to supervise these researches and follow up the results.
- The private sector companies, in cooperation with the universities and the ministries of agriculture, must adopt scientific projects based on the results of this research for their cost-effectiveness and productivity. It also plays a major role in reducing environmental pollution and reducing the problem of unemployment.

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