Study on growth performance of *Stevia rebaudiana* by chemical fertilizer and green manure on BRIS soil

by

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DECLARATION

I declare that this thesis entitled "Study on growth performance of *Stevia rebaudiana* by chemical fertilizer and green manure on BRIS soil" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

BRIS soil is the problematic soil in Malaysia because it retain a high sandy texture, low fertility and low water holding capacity. The application of chemical fertilizer and *sesbania grandiflora* as green manure is to increase the fertility of BRIS soil towards the crop production. This study was carried out to estimate the fertility of BRIS soil by determine the growth performance of *Stevia rebaudiana* under three different media, which is BRIS soil as control soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure with two light condition, 30% and 50% light intensities. The parameters that evaluated were growth performance (height of plants, number of branches, number of leaves, diameter of stem and length of roots) and biomass production. Results indicate that the highest mean average in number of leaves (4.17) in lighting 50% and number of branches (91.2) at lighting 30% by adding the chemical fertilizer. Results the number of branches showed that the three media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) have the highest mean average in lighting 30% compared to in lighting 50% which is BRIS soil (6.72), BRIS soil + Chemical Fertilizer (4.32) and BRIS soil + Green Manure (2.97). The diameter of stem showed that the highest mean average (2.1 mm) and the height of plants (17.77 cm) at BRIS soil in lighting 50%. The fresh and dry weight biomass production of the roots of *Stevia rebaudiana* plants were highest in the BRIS soil at lighting 30% which is 7.9925b and 3.2475c respectively. While in lighting 50%, the fresh weight and dry weight were highest in BRIS soil + Green Manure, which is 3.8300c and 1.2250b. But the fresh and dry weight biomass production of the stem of *Stevia rebaudiana* plants were highest in the BRIS soil + Cemical Fertilizer at lighting 30% which is 6.1400c and 1.9950b. While in lighting 50%, the fresh weight and dry weight were highest in BRIS soil + Green Manure, which is 7.2975c and 2.6150b respectively. By adding the chemical fertilizer, it might be affected by the reduction in photosynthesis and subsequent growth and it also can be cause by the nitrogen content in the chemical fertilizer that increase the number of leaves and number of branches. Light plays an important factor that can inflence the growth performance of *Stevia rebaudiana,* therefore this result suggested that adding the chemical fertilizer to BRIS soil under 30% lighting intensity should be used in crop production.

Kajian tentang prestasi pertumbuhan *Stevia rebaudiana* oleh baja kimia dan baja hijau di tanah BRIS

ABSTRAK

Tanah BRIS adalah tanah yang bermasalah di Malaysia kerana ia mengekalkan tekstur berpasir yang tinggi, kesuburan yang rendah dan kapasiti pegangan air yang rendah. Penggunaan baja kimia dan *sesbania grandiflora* sebagai baja hijau adalah untuk meningkatkan kesuburan tanah BRIS ke arah pengeluaran tanaman. Kajian ini dijalankan untuk mengkaji kesuburan tanah BRIS dengan menentukan prestasi pertumbuhan pokok *Stevia rebaudiana* dibawah tiga media yang berlainan, iaitu tanah BRIS sebagai tanah kawalan, tanah BRIS + Baja Kimia dan tanah BRIS + Baja Hijau dengan dua kondisi cahaya, iaitu 30% dan 50% keamatan cahaya. Parameter yang dinilai ialah prestasi pertumbuhan (tinggi pokok, bilangan dahan, bilangan daun dan diameter batang) serta pengeluaran biojisim. Keputusan menunjukkan bahawa purata yang paling tinggi untuk jumlah bilangan daun adalah (4.17) dalam pencahayaan 50% dan bilangan dahan (91.2) pada pencahayaan 30% dengan menambah baja kimia. Keputusan menunjukkan bahawa bilangan dahan dalam tiga media (BRIS tanah, tanah BRIS + Baja Kimia dan tanah BRIS + Baja Hijau) mempunyai nilai purata yang tertinggi dalam 30% keamatan cahaya berbanding di 50% keamatan cahaya dimana masing-masing mununjukkan tanah BRIS (6.72), tanah BRIS + Baja Kimia (4.32) dan tanah BRIS + Baja Hijau (2.97). Diameter batang menunjukkan bahawa nilai ketinggian minimum (2.1 mm) dan ketinggian maksimum (17.77 cm) di tanah BRIS dalam pencahayaan 50%. Pengeluaran berat segar (7.9925b) dan berat kering akar (3.2475c) *Stevia rebaudiana* yang tertinggi adalah di tanah BRIS pada pencahayaan 30%. Dalam pencahayaan 50%, berat segar (3.8300c) dan berat kering (1.2250c), dimana masing-masing menunjukkan nilai purata paling tinggi dalam BRIS tanah + Baja Hijau. Tetapi pengeluaran berat segar (6.1400c) dan berat kering (1.9950b), masing-masing menunjukkan batang *Stevia rebaudiana* yang tertinggi adalah di tanah BRIS + Baja Kimia pada pencahayaan 30%. Pada pencahayaan 50%, berat segar dan berat kering yang tertinggi adalah pada tanah BRIS + Baja Hijau, dimana 7.2975c dan 2.6150b. Dengan menambah baja kimia, ia mungkin dipengaruhi oleh pengurangan dalam fotosintesis dan pertumbuhan seterusnya dan ia juga boleh disebabkan oleh kandungan nitrogen dalam baja kimia yang meningkatkan bilangan daun dan bilangan dahan. Cahaya memainkan faktor penting yang boleh mempengaruhi prestasi pertumbuhan *Stevia rebaudiana*, oleh itu keputusan ini mencadangkan bahawa penambahan baja kimia untuk tanah BRIS di bawah keamatan cahaya 30% harus digunakan dalam pengeluaran tanaman.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BRIS	Beach Ridges Interspersed with Swales
cm	Centimeter
DAT	Days After Transplanting
g	gram
ha	Hectares
km	Kilometer
m	Meter
mm	milimeter
NPK	Nitrogen: Phosphorous: Pottasium
BRB	Biomass root before
BRA	Biomass root after
BSB	Biomass shoot before
BSA	Biomass shoot after

LIST OF SYMBOLS

˚C	Celsius
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Background of study

BRIS (Beach Ridges Interspersed with Swales) soils in Peninsular Malaysia are mostly found near the coastal area in Terengganu, Pahang and Kelantan (Usman *et al*., 2014). The BRIS soil covers about 155 400 hectares in Peninsular Malaysia and about 40 000 hectares in Sabah. Furthermore, the BRIS soil is the problematic soil in Malaysia because it retain a high sandy texture, low fertility, low cation exchange capacity and low water holding capacity (Mohd Khairi *et al*., 2011).

The previous study area by (Roslan *et al*., 2011) indicated that the only crop grown that can feasible and profitable on the soil over the years are tobacco and this BRIS soil are very common in the Kelantan-Terengganu Plains, Malaysia as shown in Figure 1.1. Besides that, these plains are dominated by soils having sand texture that called as BRIS soils which the beach ridges interspersed with swales that found between the ridges and the land areas are mostly covered with grasses, small shrubs and casuarina species.

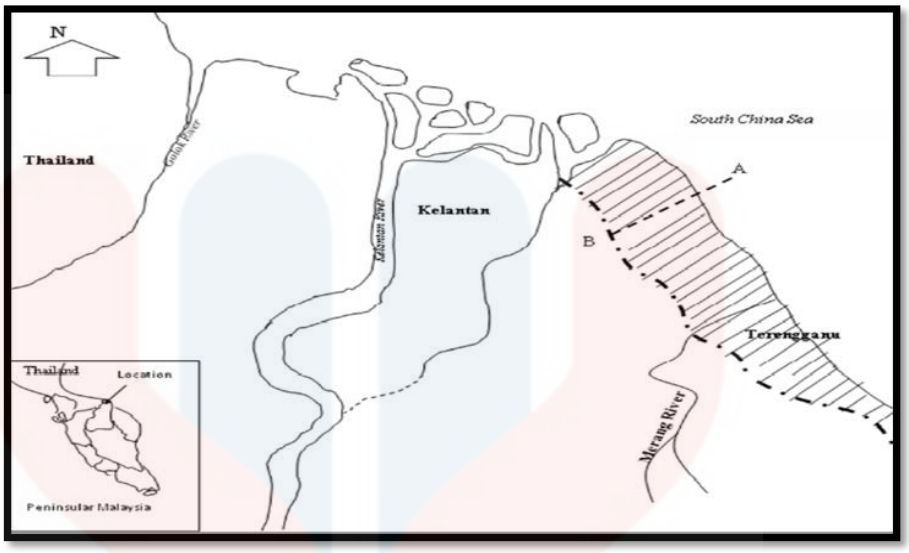

Figure 1.1 : A map showing Kelantan-Terengganu Plains, dominated by sandy beach ridges with swales (A-B are presence of ridges with sandy Spodosols and swales in depression area)
Source : (Roslan *et al*., 2011).

Stevia rebaudiana is an herbaceous parennial plants of the Asteraceae family and commonly known as sweet leaves, sweet herb and honey leaf. The leaves of this plants are 200-300 times sweeters than sugar (Anand & Prawal, 2015). The compounds in the leaves are called stevioside and rebaudioside. *Stevia rebaudiana* has gained attention with the rise in demand for low-carbohydrate, low-sugar food additive (Prodhan *et al*., 2010). It has a negligible effect on blood glucose, even enhancing blood glucose tolerance (Curi *et al*., 1986). The previous study (Andola *et al*., 2011) *Stevia rebaudiana* is useful for people with diabetes, hypoglycemia, and candidiasis of as it is a natural plant product. Glucose has high intensity calory of sweeteners, so the people now being focused on finding natural sweeteners without health risk. The Figure 1.2 shown the plant of *Stevia rebaudiana*.

Figure 1.2 : *Stevia ribaudiana* Plant.
Sources: (Tan *et al*., 2008)

Sesbania grandiflora is a plant from the family leguminosae and commonly known as Agati in Hindi (Ishwer *et al*., 2012). The Malay names of this plant are called turi and geti. *Sesbania grandiflora* is native to tropical Asia and is widespread in Malaysia, Indonesia, Philippines, and India (Noviany *et al*., 2012). The parts of this plants like fruits, falling leaflets and flowers make excellent green manure or mulch that can improve the fertility of soils. It is a best annual for close planting, growing for short periods and ploughing under to improve soil before planting food crops. *Sesbania grandiflora* is also can be use to shade nurseries and some crops such as coffee, tea and cocoa (Orwa *et al*., 2009).

Therefore, the identification and improvement the fertility of BRIS soil towards the particular plants are very importance in soil conservation and crop production system that can provide information on optimized crop inputs, weed and disease control. Therefore, this experiment was conducted to study the best treatment of media and light intensity to obtain the better growth performance and also created awareness about the natural herb and the products manufactured by the industries.

1.2 Problem of statement

The BRIS soil is commonly known as a problematic soil in Malaysia and not well utilized for crop production due to their inherent poor fertility (Roslan *et al*., 2011) because of the disadvantages of the soil such as high sandy texture, low fertility, low cation exchange capacity and low water holding capacity. Previous research (Mohd Ekhwan *et al*., 2009) showed that the BRIS soil have low pH value which is less than 5 indicating that it is acidic. The chemical fertilizer need to be applied when the plants do not get enough nutrient that they need. The typical symptoms that the plants do not get enough nutrient are the leaves have a pale green colour, yellowish or have reddish spotting and the nutrient-deficent plants are small (FAO, 2000). The previous research (Anton & Francis, 2014) showed the BRIS soil is known as a problematic soil, the green manure also will be used to improve the soil structure, soil microbiology and reduce soil pests and diseases as other treatment in this study.

Light is known to play important roles in plant development as it is necessary condition for photosynthesis process and the light can influence on seed germination. Light generally is a necessary factor for plants to photosynthesize and produce food in the form of carbohydrate which is then utilized for plant's growth and structural development (Mohamad & Raji, 2011). Besides that, due to sedentary life style, many people nowadays suffered from obesity and diabetic condition, so *Stevia rebaudiana* as a non-caloric and natural sweeteners are safe to the people who are suffered from obesity and diabetic condition (Tan *et al*., 2008; Anand *et al*., 2015). Therefore, there is an increasing tendency towards consuming natural products for a natural life (Anon., 2004).

This study will be conducted to obtain a better understanding about the different fertility of media which is BRIS soil, BRIS soil with chemical fertilizer and BRIS soil with green manure under different lighting treatment on the performance growth of *Stevia rebaudiana*. Therefore, this study are relevant to helping reducing unanswerable related to questions especially on BRIS soil fertility. There are as follow:

1. How the level of growth performance of *Stevia rebaudiana* in three different level fertility of media?

2. What the comparison the growth of *Stevia rebaudiana* in the different light intensity?

1.3 Objectives

The main focus of this study is to estimate the different level of fertility of BRIS soil, BRIS soil with chemical fertilizer and BRIS soil with green manure towards the growth performance of *Stevia rebaudiana* in two light condition. The objectives of this study are :

1. To determine the growth performance of *Stevia rebaudiana* in three different media (aplication of chemical fertilizer on BRIS soil, green manure on BRIS soil and BRIS soil)
2. To compare the growth performance of *Stevia rebaudiana* in the different lighting intensities (30% and 50%).

1.4 Significant of study

The benefits that can be obtain from this study are the fertility of soil types that can produces a good crop. The BRIS soil, BRIS soil with chemical fertilizer and BRIS soil with green manure will be used in this study to identify the benefits of the BRIS soil towards the growth performance of *Stevia rebaudiana* with two light condition. Besides that, this study will conducted in order to study the cultivation of *Stevia rebaudiana* in BRIS soil, considering the possibility to offer a new posible crop that can be used by the family farming with a short-term cultivation crop. It will help the farmers to improve their living cost when the stevia product increase in food industry or medical field.

Therefore, from this study, the fertility of BRIS soil mixture with the green manure and chemical fertilizer can be obtain from the growth performance of *Stevia rebaudiana*. The used of *Sesbania grandiflora* as green manure is to give the different fertility for BRIS soil to determine the growth performance of *Stevia rebaudiana* based on the different lighting.

1.5 Limitation of study

The plants will stop growing once the flower start blooming but it tends to grown tall and lanky (Tan *et al*., 2008; Anon, 2004). From the observation within week 1 to week 10, the plants of *Stevia rebaudiana* at lighting 50% start flower so early than lighting 30%. Therefore, it is necessary to ensure that the plants of *Stevia rebaudiana* do not flower so early so that can leaving sufficient time for the crop to develop more biomass. It is also effect the height of plant which the mean average of height of *Stevia rebaudiana* at lighting 50% was higher than in lighting 30%.

CHAPTER 2

LITERATURE REVIEW

2.1 BRIS soil

2.1.1 General

BRIS (Beach Ridges Interspersed with Swales) soil are very common in the Kelantan - Terengganu Plains (Roslan *et al*., 2011) and it is the problematic soil in Malaysia that can be found in between 0.2 – 8.0 km from the sea beach. Dune ridge forms an extensive coastal dune confined only to the east coast of Peninsular Malaysia and the total cover of dune ridge soil in Peninsular Malaysia is approximately 155, 400 ha and distributed across Kelantan (17, 806 ha), Terengganu (67, 582 ha), Pahang (36, 017 ha) and a small part of Johore (Mohd Ekhwan *et al*., 2009). From the previous study (Roslan *et al*., 2011), the BRIS soil in Malaysia are not well utilized for crop production due to their inherent poor fertility of the sandy soils that causes a water deficit and low nutrient holding capacity.

BRIS soil lacks in many aspects such as high sandy texture, nutrient deficient, low cation exchange capacity, low water retention capacity, limited ability to support plant growth and having a relatively high soil temperature (Mohd Khairi *et al*., 2011). The previous research (Mohd Ekhwan *et al*., 2009) showed that, the maximum soil temperature was found to be 36˚C and the minimum is 24˚C. The high soil temperature can be cause by the speedy vaporisation of moisture and nitrogen on soil surface and for this reason, the BRIS soil have a low moisture content. BRIS soil has a high percentage of sand and this can bothers the growth of plants. In addition, the Department of Agricultue devides BRIS soil into two orders, namely

Entisol and Spodosol. Entisol is a young soil without a podogenetic horizon that is found near the sea and has a high sand content, while the Spodosol is acidic soil with a sandy texture but unstructured with a acidic humus content (Mohd Ekhwan *et al*., 2009).

2.1.2 Chemical and physical properties

Chemical and physical attributes of dune ridge soil contribute to their oligotrophic conditions. Dune ridge soil is structurally weak with more than 95% sand and very low percentage of clay and silt. The BRIS soil is highly acidic which is the value of pH is less than 5 indicating that acidity can be treat to crop growth (Roslan *et al*., 2011). But the previous study (Mohd Khairi *et al*., 2011) showed that the application of fertilizer can increase the pH value near to the neutral condition. This result indicates that the compound of fertilizer can increase the BRIS soil health and increase the nutrients availability in BRIS soil. The addition of fertilizer to acids soil can reduces or eliminates aluminium or manganese toxicity. The natural vegetation at the area of soil that have low nutrients demanding plant species could have provided organic materials, but the humus is acid and cannot produce soil humus especially in the topsoil, because this acidic humus is not be able to support high biological activities in BRIS soils (Usman *et al*., 2014).

2.2 *Stevia rebaudiana*

2.2.1 General

Stevia rebaudiana is a parennial herb that having medicinal and commercial importance. It is belongs to the Asteraceae family. Accessions of *Stevia rebaudiana* were introduced from Russia, Paraguay, Canada, USA and Japan. Curretly, Japan used the *Stevia rebaudiana* on large scale and it is commonly known as "sweet leaf" and "honey leaf" (Anand & Prawal, 2015). *Stevia rebaudiana* is a short-day plant and the flowers of this plant are tiny white (Esra *et al*., 2016). The compounds in the leaves are called stevioside and rebaudioside and they can be more than 300 times sweeter than sucrose. Therefore, the leaves of *Stevia rebaudiana* that have commercial importance due to the presence of non-caloric sweet glycosides and it is the natural sweetener and there is no side-effect (Rakesh & Saurabh, 2012).

For this reason, the interest in this plant has increase in recent years because of its potential as a non-caloric natural sweetener. *Stevia rebaudiana* has gained attention with the rise in demand for low-carbohydrate, low-sugar food additive. It is a safe substance for consumption for people who need to reduce the sugar content on their blood and it is save for diabetics, as it does not effect the blood sugar levels (Prodhan *et al*., 2010; Mohamad & Raji, 2011). Therefore, the leaf extract of this plant has been used traditionally in the treatment of diabetes. It is extremely used by food and flavors industry because of *Stevia rebaudiana* sweeteners are natural plant products (Andola *et al*., 2011).

Stevia rebaudiana can grows up within 2-4 feet in height with slender, branched stems, and flourishes well all over temperate and can live for three to four years. It will stop growing once they bloom as the flowers are borne at the tips of the branches or stem. In Malaysia, because of short day length conditions, the plants have to be harvested much earlier before they flower (Mohamad & Raji, 2011). *Stevia rebaudiana* can be planted in many ways, but there are basically two options for multiplication which is with the tissue culture and stem cutting. Tissue culture is the best options but many farmers are tempted to try the stem cutting method for multiplication (Anon., 2004).

2.2.2 Chemical properties

Stevia rebaudiana consists of eight glycosides named as stevioside, steviolbioside, rebaudiosides A-E, and dulcoside A. These eight glycoside are one called stevioside which is 300 times sweeter than sugar (Ranjan *et al*., 2011). From the major sweet diterpene glycoside sweeteners, it present in *Stevia rebaudiana* leaves only two, which is stevioside and rebaudioside A. Stevioside are between 110 and 270 times sweeter than sucrose, and rebaudioside A between 150 and 320 times sweeter (Brandle *et al*., 1998). The previous study (Esmat *et al*., 2010), the leaves of *Stevia rebaudiana* are a good source of carbohydrates, protein, and crude fiber which are essential factors for maintenance of health and it is also the consumers benefited when the leaves of *Stevia rebaudiana* was used as substitutes of sugar in place of pure stevioside in different food preparations.

2.3 *Sesbania grandiflora*

2.3.1 General

Sesbania grandiflora is plant from family leguminosae and commonly known as Hummingbird Tree and Butterfly Tree. The Malay names of this plant are turi and geti (Noviany *et al*., 2012). The previous study (Orwa *et al*., 2009), *Sesbania grandiflora* is a species of tropical climate, short lived, quick growing and soft wooded tree and this species are fast growing, hence does not live long and can be harvested on a 3 rear short rotation. But the growth rate of *Sesbania grandiflora* are depends on the type of soil, cultural practices and amount of water available, which can be supplemented by irragation. *Sesbania grandiflora* can be grown on a wide range of soils including those that are poor and waterlogged and it tolerate saline and alkaline soils and has some tolarance to acidics soils down to water pH 4.5.

2.3.2 Characteristic

Sesbania grandiflora can grows up to 6-9 meters high and the flowers are fleshy with large showy white, pink or crimson petals (Venkateshwarlu *et al*., 2012). All part of *Sesbania grandiflora* have been used empirically as a traditional remedy in folk medicine to treat various diseases such as catarrh, dysentery, fevers, headaches, smallpox and sore throat (Noviany *et al*., 2012).

2.3.3 Chemical and physical properties

The crushed leaves of *Sesbania grandiflora* are applied to sprains and bruises of all kinds. It leaves have antibiotic, anthelmintic, antitumour and contraceptive properties. The bark is also considered as a tonic and antipyretic, a remedy for gastric troubles and the bark decoction is taken orally to treat fever and diabetes (Orwa *et al*., 2009).

2.4 Chemical fertilizer (NPK)

2.4.1 General

Fertilizer is the nutrients that needed by plants are taken from the air and from the soil. It is necessary to apply the fertilizer to the soil to keep the plants stay healthy. With the fertilizer, crops yields can often be doubled or even tripled. Chemical fertilizer are represent three different compounds which the Nitrogen, Phosphorous and Pottasium that can be describe with the letters N-P-K. Generally, there are three numbers that describe the concentration of N-P_2O_5-K_2O. For example a fertilizer bag of diammonium phosphate will have the numbers 18-46-0 on it, which means it contains a minimum of 18 percent N, 46 percent P_2O_5, and no K_2O by weight. It is important to recognize that because it would have to apply to get the same nutrient application (Rory & Mark, 2009).

2.4.2 Function of N-P-K

The function of Nitrogen (N) is for the plant growth. It makes up 1 to 4 percent of dry matter of the plant. It is involved in all the major processes of plant development and yield formation. It is important to give the good supply of nitrogen

to the plant for the uptake of the other nutrients. Then, the function of Phosphorous (P) is to transfer energy, which makes up 0.1 to 0.4 percent of the dry matter of the plant. It is essential for photosynthesis and other chemico-physiological processes in the plant. While the Pottasium (K) makes up 1 to 4 percent of the dry matter of the plant and has many function. It plays a vital part in carbohydrate and protein synthesis. Pottasium also can improve the water regime of the plant and increase its tolerance to drought, frost and alinity. The plants that well supplied with the Pottasium are also affected by disease (FAO, 2000).

2.5 Green manure

2.5.1 General

Green manure is known as a crop grown that can increase the fertility of soil that decrease due to intensive cultivation of crops. They are usually incorporated into the soil shortly before sowing the next cash crop and it is the environmentally sustainable way and it is less prices more than the fertilizer. Moreover, the benefits of the green manure are as a nitrogen management, soil improvement, ensuring the nitrogen needs of the next crop are met, weed, pest and disease control and forage for livestock (Anton & Francis, 2014). Green manure is the cheapest and the best source of organic matter and it can increased the water holding capacity of soil. Other than that, it can improves water permeability and soil tilth and can reduce the leaching of mineral nutrients and also increased the yield of crop. *Sesbania grandiflora* could play vital role as green manure to maintain the productivity (Abro & Abbasi, 2002).

2.6 Biomass production

The previous study (Diovany *et al*., 2012), showed that the interaction between the organic fertilizer type and the mode of application in the agriculture will be influenced the fresh and dry weight of plants. The application of NPK at the rate of (4g) is the most effective on increasing the fresh weight of roots and shoots and significantly increased the number of leaves, diameter of stem and length of roots. However, the percentage of water content of the stems and leaves will be increases until the time of flowering but decreases significantly just after the flowering (Afaf, 2012; Sande, 1928). The growth of plants is controlled by their genetic and by several environmental factors, such as water stress and it can be characterized by continuous water loss through transpiration into the atmosphere and by decreased water uptake that caused by reduced soil moisture. The collection and distribution of dry mass are major considerationsto identify the effect of water stress on plant growth. Plant photosynthesis is closely affected by environmental factors, such as water stress. Therefore, study on plant photosynthesis and biomass allocation under water stress is important for revealing the mechanism by which plants adapt to drought (Youyan *et al*., 2015).

2.7 Light

Light play the important roles in plant development as it is a necessary condition for photosynthesis to occur. The photosynthesis are utilized to feeds the plants, assist in cellular activities and also to support the plant's growth and structural development. The effects of light is an important factor that can influence the seed germination and seedling growth of some plants (Mohamad & Raji, 2011). From the previous study, the presence of light can influence some seeds to germinate but in some seeds, it can bring inhibation (Esra *et al*., 2016). Anchalee (2011), reported that the light is an important factor responsible for both seed germination and seedling growth.

CHAPTER 3

MATERIALS AND METHOD

3.1 Material

3.1.1 Materials

The growth performance of *Stevia rebaudiana* were this carried out at the Agropark Universiti Malaysia Kelantan from August to October 2016. Three different treatment will be used which is BRIS soil, BRIS soil with green manure and BRIS soil with chemical fertilizer (NPK blue). The BRIS soil were collected from the Universiti Malaysia Kelantan Campus Bachok and the cutting of *Stevia rebaudiana* ware purchased with supplier in Kelantan area. Then, the *Sesbania grandiflora* were used as green manure also collected from Pasir Mas, Kelantan. The stem cutting of *Stevia rebaudiana* were used as experimental materials and the transplanting was done in different media that filled in 24 polybags. The chemical fertilizer (NPK blue with ratio 15:30:15) also will be purchase from the supplier in Kelantan area. The source of water for the watering purpose of the trees can get from the Agropark Universiti Malaysia Kelantan and the net was used as a shading to cover the plants as light intensity.

3.1.2 Apparatus

The other necessary equipment for planting that have been used were cutter, hoe, sand scoop, gloves and watering can. The graduated meter ruler were used to measured the height of the plant from top soil surface up to the highest leaf tip by straightening all leaves and length of root in cm (Anand & Prawal, 2015). *Stevia rebaudiana* were harvested and their biomass was immediately weighted on

laboratory weighing balance and dried into an oven to determine fresh and dry weight of shoots and roots (Pilipovic *et al*., 2012).

3.2 Preparation of sample

The BRIS soil were collected at two different area which is at Universiti Malaysia Kelantan Campus Bachok and Kg Mujur, Beris Lalang at Bachok Kelantan as shown in Figure 3.1 and the BRIS soil was mixed together before sieved through a 1.5mm sieve to made free from plants residues and others extraneous materials (Zaman *et al*., 2015) as shown in Figure 3.2 before the BRIS soil will poured into 24 polybags. The physical and chemical properties of BRIS soil will be recorded (Khanom *et al*., 2008). The stem cuttings of stevia were transplanting into the 24 polybags that filled with the BRIS soil, BRIS soil with chemical fertilizer (NPK blue) and BRIS soil with green manure and placed under two different light intensities which is 50% and 30% of light intensities. While the green manure and chemical fertilizer (NPK blue) were used as treatment factor in this experiment. Chemical fertilizer (NPK blue) was applied one day before transplanting and the rest applied at ±20 and ±40 days after transplanting (DAT) (Khanom *et al*., 2008).

Figure 3.1 : Collecting BRIS soil at Bachok Kelantan.

Figure 3.2 : Process of mixing and sieving BRIS soil.

3.3 Site Preparation

The experiment was carried out at the Agropark, Universiti Malaysia Kelantan Campus Jeli that located near the fish pond and the experiment were plotted 25m^2 (5m x 5m). The site was cleaned from the grass and other vegetation as shown in Figure 3.3. The polybags were arranged with row space 20cm and column space 25cm with the light intensity of 50% and 30%. The basic Split-Plot Design involves assigning the levels of factor (A - lighting) to main plots arranged in a Completed Random Design, and then assigning the levels of a second factor (B - Media) to subplots within each main plot with 4 replication.

Figure 3.3 : Cleaning site process.

3.4 Planting of trees

Three different media namely BRIS soil, BRIS soil with chemical fertilizer (NPK blue) and BRIS soil with green manure as the treatment factor. Two light condition were used in this experiment which is 50% and 30% for the each three different media (Khanom *et al*., 2008). Total 24 plants were cultured in the whole study (Prodhan *et al*., 1020). Transplanting the stem cutting of *Stevia rebaudiana* was done in 16 August, 2016 in different media filled in polybags with two different light intensity, prepared as per treatments (Anand & Prawal, 2015).

3.5 Measurement of light intensity

Light intensity were measured at noon (1.00pm) by a Lux-meter/Light meter (Prodhan *et al*., 2010). The lighting is come from the direct sunlight and net as a shading to give the different light to the plants which is 30% and 50% (Renata & Kathia, 2014).

3.6 Determination of measuring and collecting data.

3.6.1 Growth performance

The height (cm) of *Stevia rebaudiana* was measured using a graduated meter ruler from the polybags top soil surface up to the highest leaf tip by straightening all leaves and the mean of the four plant heights were recorded propoerly (Jacob *et al*., 2014). The number of branches and number of leaves per plants were taken and measured with the standard method (Anand & Prawal, 2015). The methods can refer to the figures A1 and A2 in Appendix A.

3.6.2 Biomass production

Final harvesting was done on 18 October 2016. To obtain the dry weight, the weighed of stems and roots were cut and distributed separately in paper bags according to the treatments. The bags were put into an oven in air-tight condition at a temperature of 60°C ± 5°C and dried until a constant weight was achieved (Diovany *et al*., 2012). The weights of the stems and roots were recorded properly (Prodhan *et al*., 2010). The methods can refer to the figures B1 and B2 in Appendix B.

3.7 Experimental design

Experimental treatments comprised of following combinations of different growing media. T_1 - BRIS soil as control soil (1:0), T_2 - BRIS soil with green manure, T_3 - BRIS soil with chemical fertilizer (NPK) (Anand *et al*., 2015). The chemical fertilizer (NPK) was applied one day before transplanting and the rest chemical fertilizer (NPK) was applied at ±20 and ±40 days after transplanting at the rate of 0.5g each of the polybag (Khanom *et al*., 2008). The split-plot design was applied in this study as shown in Figure 3.4.

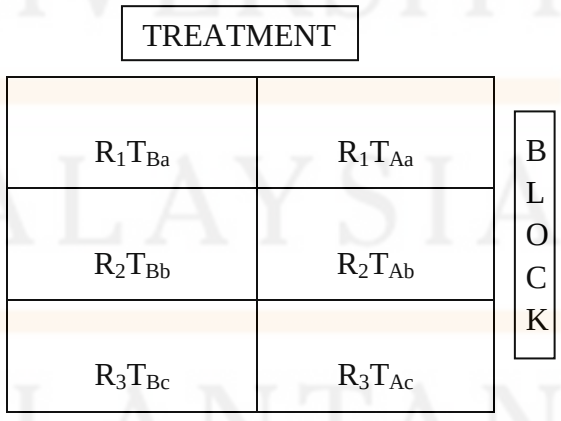

Figure 3.4 : Split Plot Design

Treatment$_1$ Ba = BRIS soil (1:0) with 50% light

Treatment$_1$ Aa = BRIS soil (1:0) with 30% light

Treatment$_2$ Bb = BRIS soil with chemical fertilizer (NPK) with 50% light

Treatment$_2$ Ab = BRIS soil with chemical fertilizer (NPK) with 30% light

Treatment$_3$ Bc = BRIS soil with green manure with 50% light

Treatment$_3$ Ac = BRIS soil with Green manure with 30% light

3.8 Layout and design

Figure 3.5 shown the experimental plot design that was applied in field with four replication of all the treatments. The treatments are BRIS soil, BRIS soil with chemical fertilizer (NPK) and BRIS soil with green manure. The letter A is indicates the used of 30% lighting and B is indicates the used of 50% lighthing.

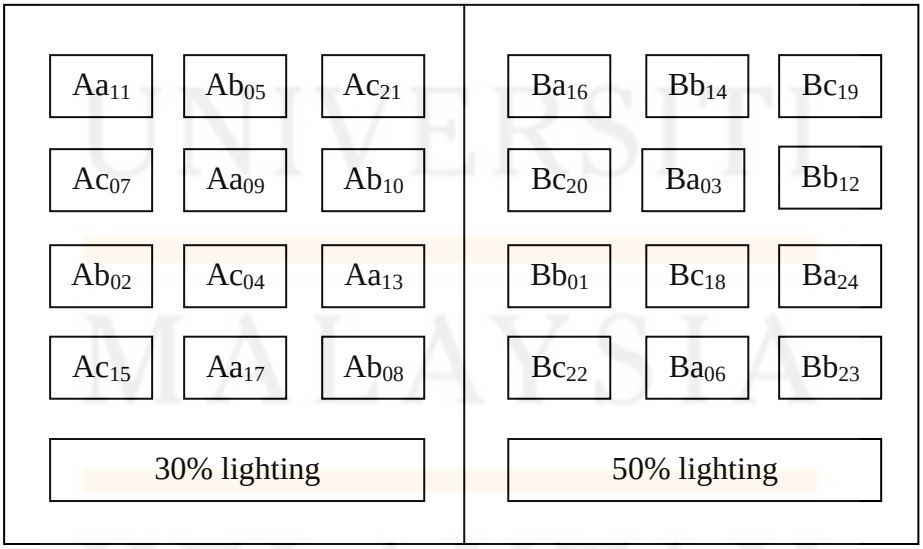

Figure 3.5 : Experimental plot setup

Table 3.1 shown the arrangement of *Stevia rebaudiana* plants for each treatment based on Complete Randomized Design (CRD) from the table of random number that can refer to the Appendix D.

Table 3.1 : Arrangement based on Complete Randomized Design (CRD)

Light	Type of soil	Arrangement
30%	BRIS soil	Aa_{11}, Aa_{09}, , Aa_{13}, Aa_{17}
	BRIS soil + Chemical Fertilizer	Ab_{05}, Ab_{10}, $Ab_{02,}$ Ab_{08}
	BRIS soil + Green Manure	Ac_{21}, Ac_{07}, Ac_{04}, Ac_{15}
50%	BRIS soil	Ba_{16}, Ba_{03}, Ba_{24}, Ba_{06}
	BRIS soil + Chemical Fertilizer	Bb_{14}, Bb_{12}, Bb_{01}, Bb_{23}
	BRIS soil + Green Manure	Bc_{19}, Bc_{20}, Bc_{18}, Bc_{22}

3.9 Statistical analysis

Statistics is the study of the collection, analysis, interpretation, presentation, and organization of data. In applying statistics for example a scientific, industrial, or societal problem, it is conventional to begin with a statistical population or a statistical model process to be study.

The most suitable statistical analysis for this study are descriptive and One-way analysis of variance (ANOVA). One-way ANOVA is a collection of statistical models used in order to analyze the differences between the growth performance and biomass production of *Stevia rebaudiana* in three different media and two different light intensity.

3.10 Research flow chart

Figure 3.6 shown the overall process that have been done in this research.

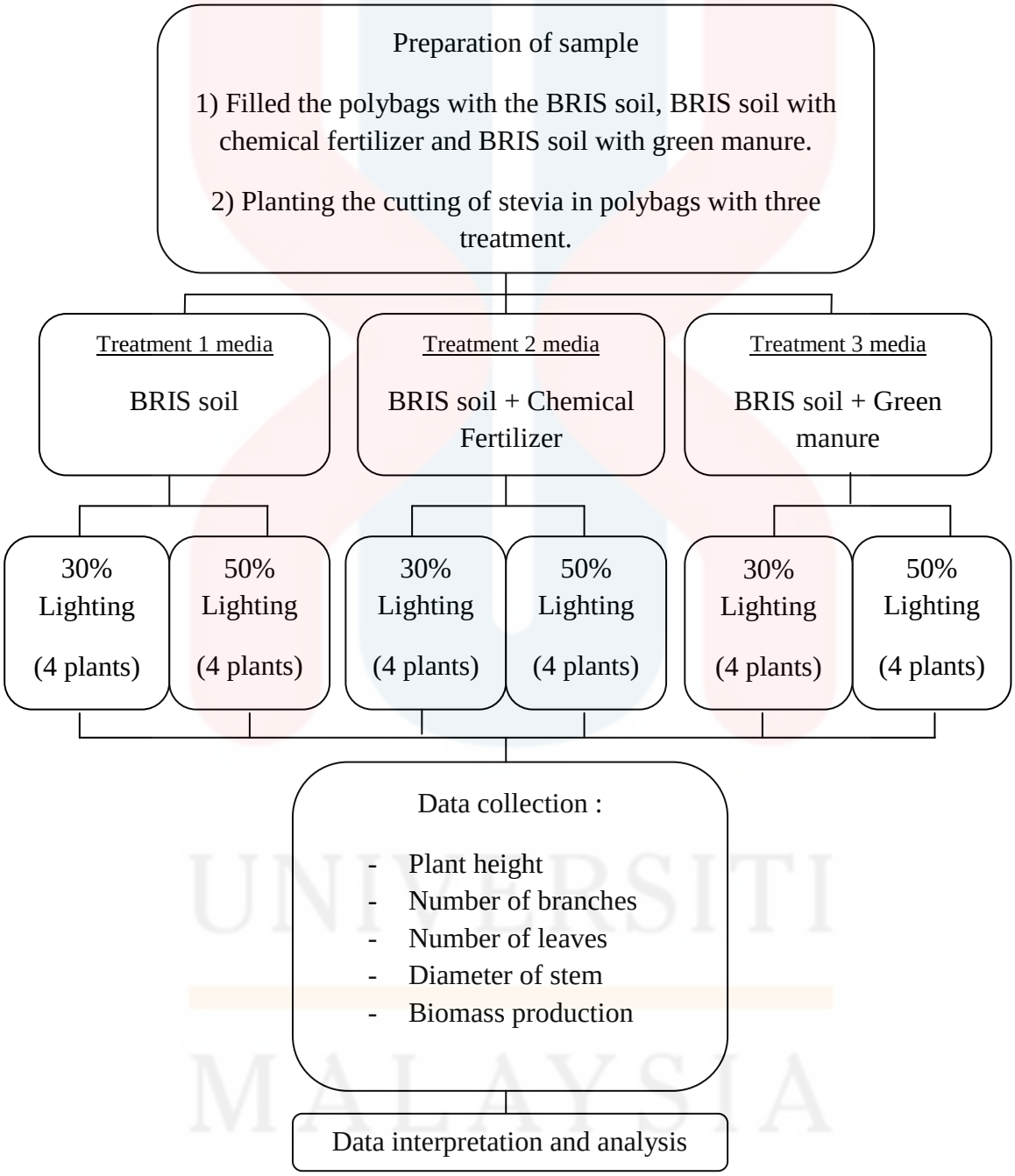

Figure 3.6 : Flow chart for methodology

CHAPTER 4

RESULTS AND DISCUSSION

This chapter present the analysis of the results, gathered in the current study and then discussion. As mention in chapter 1, the objective of this study were (i) To determine the growth performance of *Stevia rebaudiana* in three different media (aplication of chemical fertilizer on BRIS soil, green manure on BRIS soil and BRIS soil) and (ii) To compare the growth performance of *Stevia rebaudiana* in the different light intensity (30% and 50%).

For those, the result and discussion were explained in two section, which is growth performance of *Stevia rebaudiana* and production of biomass of stem and roots of *Stevia rebaudiana*. While section one consist a few section, which is (i) Identification of Height of *Stevia rebaudiana,* (ii) Identification number of branches of *Stevia rebaudiana*, (iii) Identification number of leaves of *Stevia rebaudiana,* (iv) Identification diameter of stem of *Stevia rebaudiana* and (v) Identification of biomass production of *Stevia rebaudiana*.

4.1 Growth performance of *Stevia rebaudiana*

The objective of this study are to determine the growth performance of *Stevia rebaudiana* in three different media by applied the chemical fertilizer and green manure on BRIS soil and BRIS soil as a control soil and to compare the growth performance of *Stevia rebaudiana* in the different lighting intensity (30% and 50%). The parameters that were used to measured the growth performance are height of plants, number of leaves, number of branches, diameter of stem and biomass

production. Results from this experiment indicate that the pH value of BRIS soil and BRIS soil + Green Manure were measured at the week 1 and week 10 was at the range 5-6 and the range for BRIS soil + Chemical Fertilizer was at the range 3-4.

4.1.1 Identification of height of *Stevia rebaudiana*

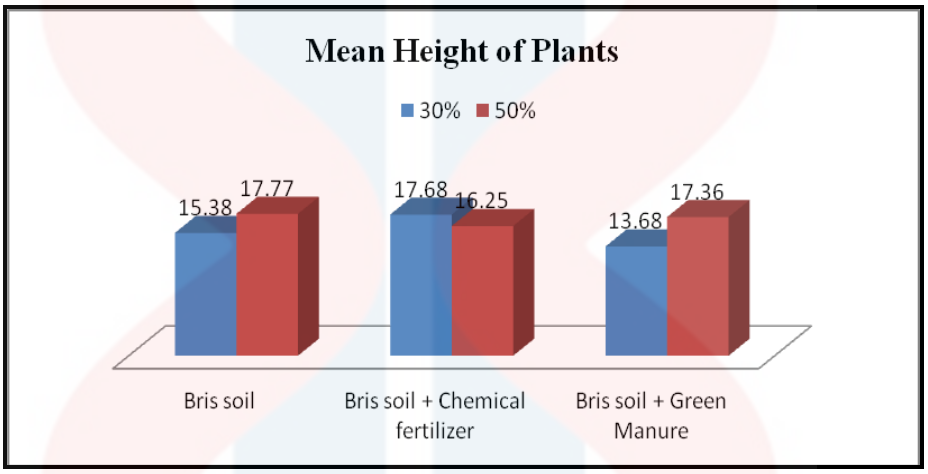

Figure 4.1 : Mean of height of *Stevia rebaudiana*

Different types of media influenced significantly the plant height of *Stevia rebaudiana.* According to the analysis that has been made, the mean average for BRIS soil in lighting 30% is (15.38 cm) and lighting 50% (17.77 cm). The tallest plant (17.62 cm) and the shortest plant (13.14 cm), but in lighting 50%, the tallest plant (20.28 cm) and the shortest plant (15.25 cm). The mean average for BRIS soil + Chemical Fertilizer in lighting 30% is (17.68 cm) and lighting 50% is (16.25 cm). The tallest plant (20.15 cm) and shortest plant (15.21 cm) was found at BRIS soil + Chemical Fertilizer in lighting 30% and the tallest plant (18.98 cm) and shortest plant (13.53 cm) in lighting 50%. The mean average BRIS soil + Green Manure for lighting 30% is (13.68 cm) and lighting 50% is(17.36 cm). The tallest plant (15.96 cm) and the shortest plant (11.39 cm) for BRIS soil + Green Manure in lighting 30% and lighting 50% are the tallest plant (20.22 cm) and the shortest plant (14.50 cm).

Lingthing of 50% showed that the highest mean average height of plants was BRIS soil and BRIS soil + Green Manure. From the observation on plants of *Stevia rebaudiana* from week 1 to week 10, the flowers start flowering at the week 5 at BRIS soil and BRIS soil + Green Manure in lighting 50% and the flower start flowering in week 8 on BRIS soil + Chemical Fertilizer at lighting of 30%. It might effect the height of plants when it start flowering. (Anon, 2004) report that, when the plants of *Stevia rebaudiana* start flowering, the plants tends to grown tall and lanky.

4.1.1.1 Comparision of Height of *Stevia rebaudiana* in three different media and two light condition

Table 4.1 : Analysis of Variance (ANOVA) mean average height of *Stevia rebaudiana* in One-way ANOVA.

	Light	Df	Mean Square	F	Sig.
30%	Between Groups	2	161.180	3.029	0.052^{ns}
	Within Groups	117	53.215		
	Total	119			
50%	Between Groups	2	24.522	0.343	0.710^{ns}
	Within Groups	117	71.428		
	Total	119			

Note: Significant level at ≤0.05

The ANOVA showed that the heigth of *Stevia rebaudiana* in three different media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are not significantly difference (α=0.052) for lighting of 30% and (α=0.710) for lighting 50% at > 0.05 significant level, but result from multiple comparison shown that there have a significant difference on BRIS soil + Chemical Fertilizer and BRIS

soil + Green Manure with (α=0.041) < at 0.05 significant level for lighting 30% and no significant difference (α=0.551) > at 0.05 on BRIS soil for lighting 50%.

4.1.2 Identification of number of branches

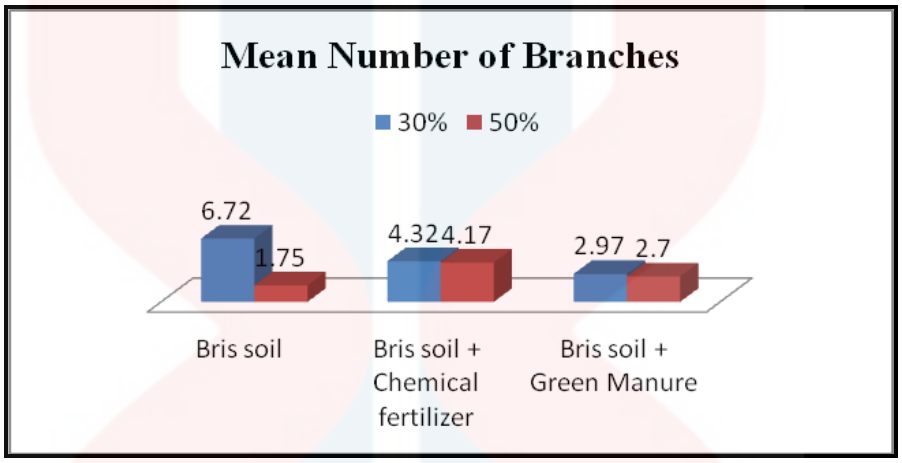

Figure 4.2 : Mean of number of branches

The number of branches was influenced by the type of media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure). According to the analysis that has been made, the mean average of number of branches on BRIS soil in lighting 30% is (6.72) while in lighting 50% is (1.75). The maximum number of branches (9.19) and the minimum (4.25), but in lighting 50%, the maximum (2.06) and the minimum (1.43). The mean average for BRIS soil + Chemical Fertilizer in lighting 30% is (4.32) and lighting 50% is (4.17). The maximum number of branches (5.14) and minimum (3.50) was found at BRIS soil + Chemical Fertilizer in lighting 30% and the maximum (5.11) and minimum (3.23) in lighting 50%. The mean average BRIS soil + Green Manure for lighting 30% are (2.97) and lighting 50% is (2.70). The maximum number of branches (3.60) and the minimum (2.34) for BRIS soil + Green Manure in lighting 30% and lighting 50% are the maximum (2.95) and the minimum (2.44).

The three media which is BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure showed that the highest mean average number of branches were in lighting 30%. The BRIS soil in lighting 30% showed the highest mean value which is (6.72), it might be caused by the low quantity of air in the soil that continuously changing because of factors like over watering, weather, plant roots and biological activity. The previous study (Joseph, 2011) stated that, the available water for plants in various types of soils will depends upon the soil texture and the water retention is strongly influenced by the clay fraction and their associated characteristics.

4.1.2.1 Comparison of Number of Branches of *Stevia rebaudiana* in three different media and two light condition

Table 4.2 : Analysis of Variance (ANOVA) mean average number of branches in One-way ANOVA.

	Light	Df	Mean Square	F	Sig.
30%	Between Groups	2	144.300	6.158	0.003*
	Within Groups	117	23.434		
	Total	119			
50%	Between Groups	2	59.725	17.661	0.000*
	Within Groups	117	3.382		
	Total	119			

Note: Significant level at ≤0.05

The ANOVA showed that the number of branches in three different media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are significantly difference (α=0.003) for lighting 30% and (α=0.000) for lighting 50% at < 0.05 significant level, but result from multiple comparison shown that there have

no significant difference on BRIS soil and BRIS soil + Chemical Fertilizer with (α=0.072) > at 0.05 significant level for lighting 30% and no have significant difference (α=0.058) > at 0.05 for lighting 50% on BRIS soil and BRIS soil + Green Manure.

Table 4.3 : Duncan's multiple range test number of branches

Lighting	Media	Mean of
	BRIS soil	6.7250b
30%	BRIS soil + Chemical Fertilizer	4.3250ab
	BRIS soil + Green Manure	2.9750a
	BRIS soil	1.7500a
50%	BRIS soil + Chemical Fertilizer	4.1750c
	BRIS soil + Green Manure	2.7000b

Note: Mean with the same letter is not significant

In Duncan's multiple range test shown the mean value which is consist of BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure in lighting 30% were determined 6.7250b, 4.3250ab and 2.9750a respectively. While for lighting 50% are 1.7500a, 4.1750c and 2.7000b. Whereas, the mean value with different letter is significant difference.

The result is similar to the (Khanom et al., 2008) where in lighting 50% showed the maximum number of branches at BRIS soil + Chemical Fertilizer was (4.1750c). But in this study, the highest mean value of number of branches in lighting 30% was at BRIS soil which is (6.7250b). There is small difference between the application of chemical fertilizer and green manure towards the growth performance of *Stevia rebaudiana* compared to the BRIS soil as a control soil in

lighting 50%. The highest mean value of number of branches at lighting 50% was 4.1750c at BRIS soil + Chemical Fertilizer, it is similar finding with the Nafiu *et al*, (2011), who stated that the highest value number of branches was recorded in the application of chemical fertilizer.

4.1.3 Identification of number of leaves

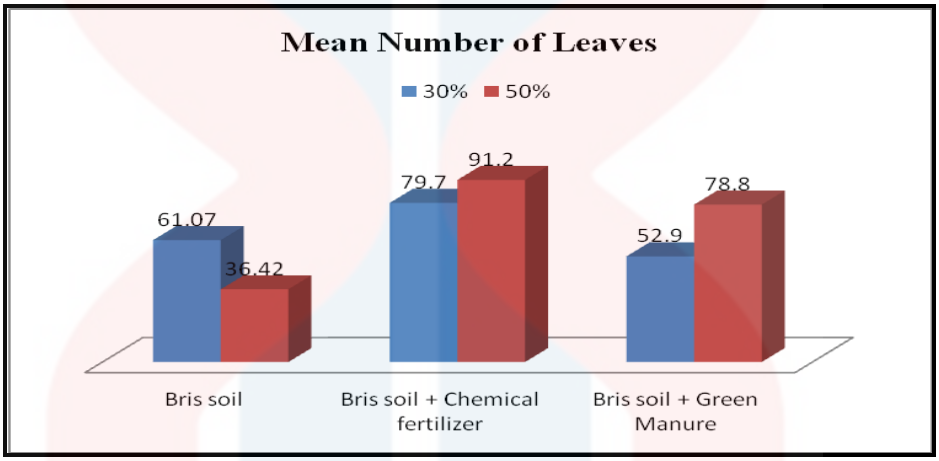

Figure 4.3 : Mean of number of leaves

According to the analysis that has been made, the mean average number of leaves on BRIS soil in lighting 30% is (61.07) while in lighting 50% is (36.42). The maximum number of leaves (75.36) and the minimum (46.78), but in lighting 50%, the maximum (41.05) and the minimum (31.79). The mean average for BRIS soil + Chemical Fertilizer in lighting 30% is (69.70) and lighting 50% is (91.20). The maximum (101.09) and minimum (58.30) was found at BRIS soil + Chemical Fertilizer in lighting 30% and the maximum (114.34) and minimum (68.05) in lighting 50%. The mean average BRIS soil + Green Manure for lighting 30% are (52.90) and lighting 50% is (78.80). The maximum (74.97) and the minimum (54.14) for BRIS soil + Green Manure in lighting 30% and lighting 50% are the maximum number of branches (100.69) and the minimum (56.90). The highest mean average of

number of leaves (91.2) was recorded from the BRIS soil + Chemical Fertilizer at 50% lighting. This may have caused by the nitrogen content in the chemical fertilizer that increase the number of leaves. Prodhan *et al*. (2010) who stated that the different type of media interacted significantly to bring variation in the number of leaves.

4.1.3.1 Comparison of Number of Leaves of *Stevia rebaudiana* in three different media and two light condition

Table 4.4 : Analysis of Variance (ANOVA) mean average number of leaves in One-way ANOVA.

	Light	Df	Mean Square	F	Sig.
	Between Groups	2	7546.408	2.324	0.102^{ns}
30%	Within Groups	117	3247.750		
	Total	119			
	Between Groups	2	32998.008	9.769	0.000*
50%	Within Groups	117	3377.800		
	Total	119			

Note: Significant level at ≤0.05

The ANOVA showed that the number of leaves in three different treatment of media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are no significantly difference (α=0.102) for lighting 30% at >0.05 significant level but there have significantly difference treatment of media (α=0.000) for lighting 50% at < 0.05 significant level. From the multiple comparison shown that there have no significant difference on BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure with (α=0.094) > at 0.05 significant level for lighting 30% and have sinificant difference (α=0.004) > at 0.05 on BRIS soil for lighting 50%.

Table 4.5 : Duncan's multiple range test number of leaves

Lighting	Media	Mean of
	BRIS soil	36.4250a
50%	BRIS soil + Chemical Fertilizer	91.2000b
	BRIS soil + Green Manure	78.8000b

Note: Mean with the same letter is not significant

In Duncan's multiple range test show the mean value which is consist of BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure in lighting 50% are 36.4250a, 91.2000b and 78.8000b. Whereas, the mean value with different letter is significant difference.

Result for the lighting 50% showed the highest mean value of number of leaves in BRIS soil + Chemical Fertilizer. It can be caused the using of NPK fertilizer that can increase the nitrogen percentage in the leaves of *Stevia rebaudiana* as compared to the BRIS soil and BRIS soil + Green Manure. According to (Azza *et al*., 2010) who stated that application of NPK influenced the increased of number of leaves.

4.1.4 Identification of diameter of stem

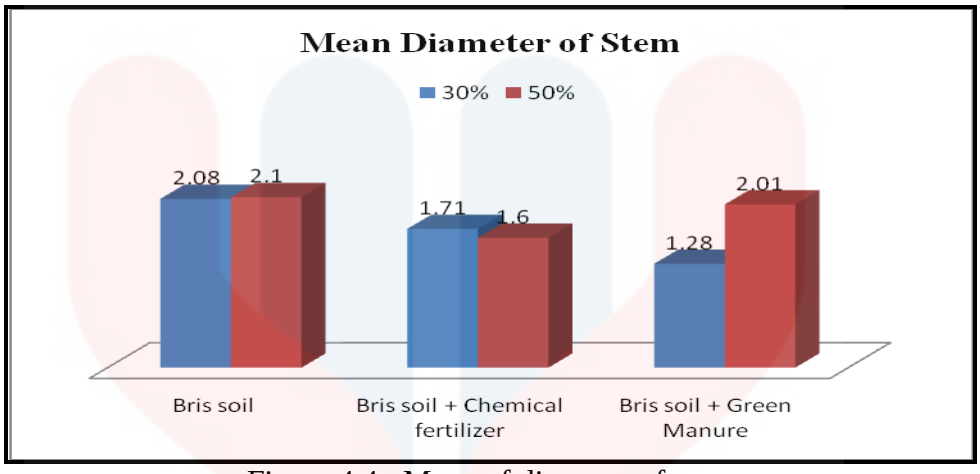

Figure 4.4 : Mean of diameter of stem

According to the analysis that has been made, the mean average diameter of stem at BRIS soil in lighting of 30% is (2.08 mm) while in lighting of 50% is (2.10 mm). The thickest plant (2.43 mm) and the thinnest plant (1.73 mm), but in lighting of 50%, the thickest plant (2.29 mm) and the thinnest plant (1.90 mm). The mean average diameter of stem for BRIS soil + Chemical Fertilizer in lighting of 30% is (1.71 mm) and lighting 50% is (1.60 mm). The thickest plant (1.86 mm) and thinnest plant (1.55 mm) was found at BRIS soil + Chemical Fertilizer in lighting of 30% and the thickest plant (1.73 mm) and thinnest plant (1.47 mm) in lighting of 50%.

The mean average diameter of stem for BRIS soil + Green Manure for lighting of 30% is (1.28 mm) and lighting of 50% is (2.01 mm). The thickest plant (1.49 mm) and the thinnest plant (1.07 mm) for BRIS soil + Green Manure in lighting of 30% and lighting of 50% are the thickest plant (2.12 mm) and the thinnest plant (1.90 mm). The highest mean value of diameter of stem can be caused by the quality of light that can effect the plant growth performance.

4.1.4.1 Comparison of Diameter of Stem of *Stevia rebaudiana* in three different media and two light condition

Table 4.6 : Analysis of Variance (ANOVA) mean average diameter of stem in One-way ANOVA.

	Light	Df	Mean Square	F	Sig.
	Between Groups	2	6.345	10.256	0.000*
30%	Within Groups	117	0.619		
	Total	119			
	Between Groups	2	2.839	12.766	0.000*
50%	Within Groups	117	0.222		
	Total	119			

Note: Significant level at ≤0.01

The ANOVA showed that the diameter of stem in three different treatment of media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are significantly difference (α=0.000) for lighting of 30% and (α=0.000) for lighting 50% at <0.01 significant level, but result from multiple comparison shown that there have no significant difference of the diameter of stem on BRIS soil and BRIS soil + Chemical Fertilizer with (α=0.091) > at 0.05 significant level for lighting 30% and also no significant difference (α=0.668) > at 0.05 on BRIS soil and BRIS soil + Green Manure for lighting of 50%.

Table 4.7 : Duncan's multiple range test diameter of stem

Lighting	Media	Mean of
	BRIS soil	2.0822b
30%	BRIS soil + Chemical Fertilizer	1.7102b
	BRIS soil + Green Manure	1.2863a
	BRIS soil	2.1020b
50%	BRIS soil + Chemical Fertilizer	1.6020a
	BRIS soil + Green Manure	2.0115b

Note: Mean with the same letter is not significant

In Duncan's multiple range test show the mean value of diameter of stem in three different media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) in lighting of 30% were determined 2.0822c, 1.7102b and 1.2863a respectively. While for lighting of 50% are 2.1020b, 1.6020a and 2.0115b respectively. Whereas, the mean value with different letter is significantly difference.

Although some differences were statistically significant, diameter of stem were not affected greatly by green manure and chemical fertilizer when the results showed the lowest mean value at BRIS soil + Green Manure (1.2863a) in lighting of 30% and BRIS soil + Chemical Fertilizer (1.6020a) in lighting 50%. It is similar finding with the Ilhan *et al*, (2005) who stated that the diameter of stem not well effected by green manuring and N fertilization treatment.

4.2 Production of biomass of shoot and roots of *Stevia rebaudiana*

Table 4.8: Fresh and dry weight of roots

Light	Media	Fresh weight of roots (g)			Dry weight of roots (g)		
		Mean	Std. Deviation	Sig.	Mean	Std. Deviation	Sig.
30%	BRIS soil	7.9925b	8.197	.000*	3.2475c	2.995	.000*
	BRIS soil + Chemical Fertilizer	3.4300a	1.448		1.6750b	0.635	
	BRIS soil + Green Manure	2.0075a	1.721		0.8100a	0.635	
50%	BRIS soil	2.2525b	1.941	.000*	1.1150b	0.886	.000*
	BRIS soil + Chemical Fertilizer	1.1175a	0.376		0.4900a	0.132	
	BRIS soil + Green Manure	3.8300c	3.084		1.2250b	0.898	

Note: Significant level at ≤0.01

The result showed that the biomass of fresh and dry weight of roots in three different treatment of media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are significantly difference (α=0.000) for lighting 30% and (α=0.000) for lighting 50% at <0.01 significant level, but result from multiple comparison shown that in lighting of 30% there have no significant difference of the biomass of fresh weight of roots on BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure with (α=0.400) > at 0.01 significant and also no significant difference (α=0.086) > at 0.01 of the biomass of dry weight of roots on BRIS soil + Chemical

Fertilizer and BRIS soil + Green Manure. While in lighting of 50% there have no significant difference of the biomass of fresh weight of roots on BRIS soil and BRIS soil + Chemical Fertilizer with (α=0.047) > at 0.01 significant and have significant difference (α=0.003) > at 0.01 of biomass dry weight of roots on BRIS soil and BRIS soil + Green Manure.

The fresh and dry weight biomass production of the roots of *Stevia rebaudiana* plants were highest in the BRIS soil at lighting of 30% which is (7.9925b) and (3.2475c). While in lighting of 50%, the fresh weight (3.8300c) and dry weight (1.2250b) were highest in BRIS soil + Green Manure. The lowest mean value of fresh weight and dry weight at lighting 30% were in BRIS soil + Green Manure which is (2.0075a) and (0.8100a) respectively and in lighting of 50%, the lowest fresh weight (1.1175a) and dry weight (0.4900a) were in BRIS soil + Chemical Fertilizer.

The result indicate that in lighting of 50%, the highest mean value of fresh and dry weight was at BRIS soil + Green Manure. The increased root dry weight might be due to the good soil condition for root penetration, spread the water and the moisture content that caused by the uncertain weather that affect to plants growth. According to the Chaukiyal, (2013), who stated that the root biomass was higher than other nitrogen treatments in winter and summer seasons.

Table 4.9: Fresh and dry weight of shoot

Light	Media	Fresh weight of shoot (g)			Dry weight of shoot (g)		
		Mean	Std. Deviation	Sig.	Mean	Std. Deviation	Sig.
30%	BRIS soil	2.0175a	1.127	.000*	0.8025a	0.480	.000*
	BRIS soil + Chemical Fertilizer	6.1400c	2.345		1.9950b	0.983	
	BRIS soil + Green Manure	3.1600b	2.149		1.1050a	0.635	
50%	BRIS soil	1.2275a	0.665	.000*	0.7200a	0.347	.000*
	BRIS soil + Chemical Fertilizer	3.9925b	2.157		1.1850b	0.603	
	BRIS soil + Green Manure	7.2975c	4.585		2.6150b	1.728	

Note: Significant level at ≤0.01

The result showed that the biomass of fresh and dry weight of shoots in three different treatment of media (BRIS soil, BRIS soil + Chemical Fertilizer and BRIS soil + Green Manure) are significantly difference (α=0.000) for lighting 30% and (α=0.000) for lighting 50% at <0.01 significant level, but result from the multiple comparison shown that in lighting of 30% there have significant difference of the biomass of fresh weight of shoots on BRIS soil and BRIS soil + Green Manure with (α=0.027) at >0.01 significant and no significant difference (α=0.158) at >0.01 of the biomass of dry weight of shoots on BRIS soil and BRIS soil + Green Manure. While in lighting of 50% there have significant difference of the biomass of fresh weight of shoots on BRIS soil and BRIS soil + Chemical Fertilizer with (α=0.000) at >0.01

significant and no significant difference (α=0.134) at > 0.01 of biomass dry weight of shoots on BRIS soil and BRIS soil + Chemical Fertilizer.

The fresh and dry weight biomass production of the shoots of *Stevia rebaudiana* plants were highest in the BRIS soil + Chemical Fertilizer at lighting of 30% which is (6.1400c) and (1.9950b). While in lighting of 50%, the fresh weight and dry weight were highest in BRIS soil + Green Manure, which is (7.2975c) and (2.6150b) respectively. It can be caused by the addition of green manure into cultivation which affect the biomass production that probably due to the increase of nitrogen.

According to the Sharda & Lakshmi, (2014) who stated that the addition of green manure into cultivation will be influence the performace of plants and may be probably due to the increase of nitrogen. The lowest mean value of fresh weight and dry weight at lighting of 30% were in BRIS soil which is (2.0175a) and (0.8025a). While in lighting of 50%, the fresh weight and dry weight were lowest is also in BRIS soil which is (1.2275a) and (0.7200a). The highest mean value was in lighting of 50% at BRIS soil + Green Manure (7.2975b). As a conclusion, the application of chemical fertilizer and green manure give the positive impact to the *Stevia rebaudiana* growth compared to the control soil at the different light intensity.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The results showed the best growth performance of plants were under lighting of 30% and the best media was BRIS soil + Chemical Fertilizer (NPK). It can be concluded that the application of chemical fertilizer (NPK) can increase the crop yield and the light plays an important factor that can influenced the growth performance of *Stevia rebaudiana.* In lighting of 30% the highest mean value of plants height and number of leaves were shown at BRIS soil + Chemical Fertilizer (NPK) which is (17.68 cm) and (79.70) respectively. The result of fresh weight and dry weight of biomass are greater in BRIS soil + Green Manure at lighting of 50% for both shoot (7.29) and (2.61) and roots (3.83) and (1.22) respectively but at lighting of 30% the highest mean was in BRIS soil + Chemical Fertilizer (NPK) for fresh and dry weight of shoot (6.14) and (1.99) and in BRIS soil for roots (7.99) and (3.24). The addition of chemical fertilizer (NPK) to the *Stevia rebaudiana* plant had increase the nitrogen content in the soil thus resulting in increasing of number of leaves and number of branches. Light plays an important factor that influence the growth performance of *Stevia rebaudiana.* Therefore this result suggested the best treatment was BRIS soil + Chemical Fertilizer (NPK) under 30% lighting intensity to obtain the better growth performance of crop production that can influence the crop yield.

5.2 Recommendations

In this study, within week 1 to week 10 the plants of *Stevia rebaudiana* start flowering at the week 5 at BRIS soil and BRIS soil + Green Manure in lighting of 50% and the flower start flowering in week 8 on BRIS soil + Chemical Fertilizer (NPK) at lighting of 30%. As recommendation for the further study, it should be ensure that the plants of *Stevia rebaudiana* should not plant under high light intensity to avoid the *Stevia rebaudiana* to flower so early so that can leaving sufficient time for the crop to develop more biomass and to improve the crop production and improve the techniques in vegetative propagation.

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APPENDIX A : Growth Performance

Figure A1: Measurement height of *Stevia rebaudian*

Figure A2: Measurement number of leaves of *Stevia rebaudian*

APPENDIX B : Biomass production

Figure B1: *Stevia rebaudiana* dried in oven

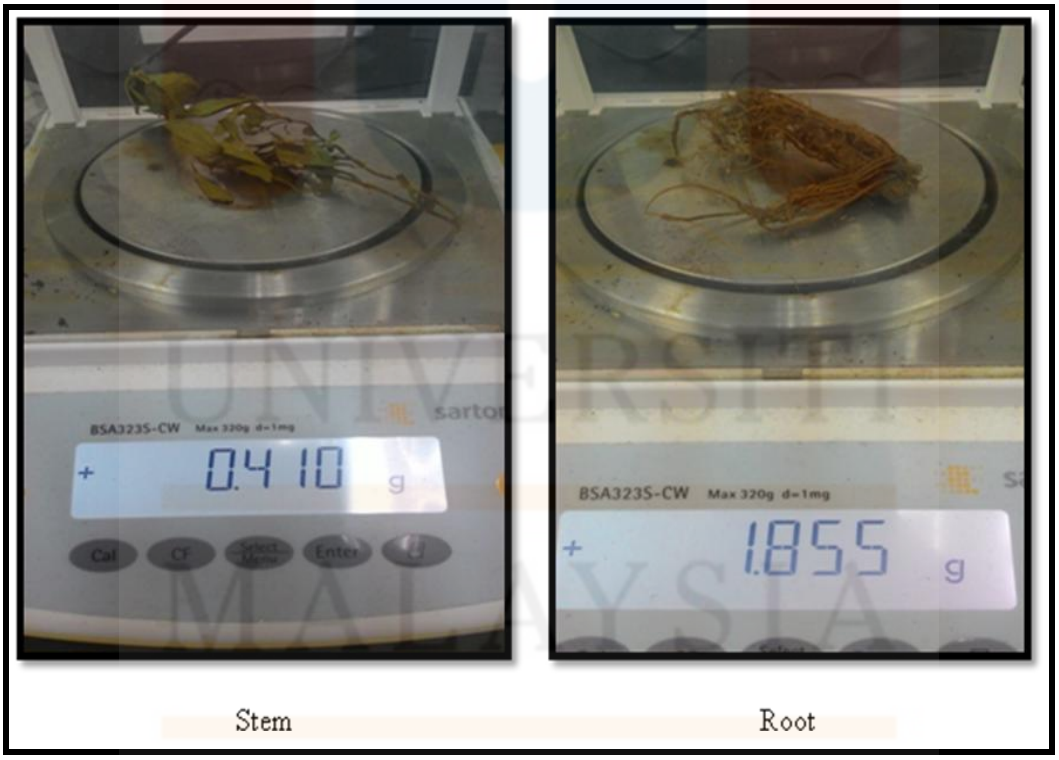

Figure B2: Dry weight of *Stevia rebaudiana*

APPENDIX C

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
	22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
	24130	48360	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
	42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
5	37570	39975	81837	16656	06121	91782	60468	81305	49684	60672	14110	06927	01263	54613
	77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
	99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
	96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
	89579	14342	63661	10281	17453	18103	57740	84378	25331	12566	58678	44947	05585	56941
10	85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
	28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
	63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12234	90511	33703	90322
	09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
	10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
15	07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
	51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
	02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
	01011	54092	33362	94904	31273	04146	18594	29852	71585	85030	51132	01915	92747	64951
	52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
20	07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
	48663	91245	85828	14346	09172	30168	90229	04734	59193	22178	30421	61666	99904	32812
	54164	58492	22421	74103	47070	25306	76468	26384	58151	06646	21524	15227	96909	44592
	32639	32363	05597	24200	13363	38005	94342	28728	35806	06912	17012	64161	18296	22851
	29334	27001	87637	87308	58731	00256	45834	15398	46557	41135	10367	07684	36188	18510
25	02488	33062	28834	07351	19731	92420	60952	61280	50001	67658	32586	86679	50720	94953
	81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
	29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
	00742	57392	39064	66432	84673	40027	32832	61362	98947	96067	64760	64584	96096	98253
	05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
30	91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
	00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
	00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
	69011	65795	95876	55293	18988	27354	26575	08625	40801	59920	29841	80150	12777	48501
	25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
35	09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
	91567	42595	27958	30134	04024	86385	29880	99730	55536	84855	29080	09250	79656	73211
	17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
	46503	18584	18845	49618	02304	51038	20655	58727	28168	15475	56942	53389	20562	87338
	92157	89634	94824	78171	84610	82834	09922	25417	44137	48413	25555	21246	35509	20468
40	14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
	98427	07523	33362	64270	01638	92477	66969	98420	04880	45585	46565	04102	46880	45709
	34914	63976	88720	82765	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
	70060	28277	39475	46473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
	53976	54914	06990	67245	68350	82948	11398	42878	80287	88267	47363	46634	06541	97809
45	76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41151	14222	60697	59583
	90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
	64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
	08962	00358	31662	25388	61642	34072	81249	35648	56891	69352	48373	45578	78547	81788
	95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
50	15664	10493	20492	38391	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653

Table of random number

Source : (William., 1968)