DETERMINATION OF BRIS SOIL PROPERTIES USING CHEMICAL FERTILIZER UNDER DIFFERENT LIGHT INTENSITY

by

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DECLARATION

I declare that this thesis entitled "Determination of Bris Soil Properties using Chemical Fertilizer under Different Light Intensity" 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.

Signature : ________________________________

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Determination of BRIS Soil Properties using Chemical Fertilizer under Different Light Intensity

ABSTRACT

BRIS soil is a type of sandy soil and has limited ability to support plant growth due to it poor of chemical and physical characteristic of soil. The research objectives focus on the effect of chemical fertilizer on BRIS soil properties under different shading area and to study the effect of different amount of light intensity (30% and 50%) on properties of BRIS soil. The design was layout by split plot design with two different media, BRIS soil with and without chemical fertilizer under different amount of light intensity (30% and 50%). The applying of chemical fertilizer and effect of 50% light intensity on BRIS soil were more effective in increasing the amount of organic matter, availability of Potassium (K) and Phosphorus (P) in soil and performance growth of *Arachis hypogaea*. The overall result showed that the BRIS soil with applying of chemical fertilizer with exposes of 50% light intensity can increase the fertility of BRIS soil and plant production. On other hand, the soil pH values were found to be slightly acidic to acidic.

Penentuan Sifat Tanah BRIS Menggunakan Baja Kimia di bawah Keamatan Cahaya Yang Berbeza

ABSTRAK

Tanah BRIS adalah sejenis tanah berpasir dan mempunyai keupayaan yang terhad untuk menyokong pertumbuhan tumbuhan kerana ia miskin dengan ciri kimia dan fizikal tanah. Objektif penyelidikan memberi tumpuan kepada kesan baja kimia ke atas sifat tanah BRIS di bawah kawasan teduhan yang berbeza dan untuk mengkaji kesan jumlah keamatan cahaya yang berbeza (30% dan 50%) ke atas sifat tanah BRIS. Reka bentuk disusun atur oleh rekaan plot pecahan dengan dua media yang berbeza, tanah BRIS dengan dan tanpa baja kimia di bawah jumlah yang berbeza keamatan cahaya (30% dan 50%). Dengan menggunakan baja kimia dan kesan dari 50% keamatan cahaya ke atas tanah BRIS lebih memberi kesan dalam meningkatkan jumlah bahan organik, ketersediaaan Potassium (K) dan Fosforus (P) dalam tanah dan prestasi pertumbuhan *Arachis hypogaea*. Keputusan keseluruhan menunjukkan bahawa tanah BRIS dengan menggunakan baja kimia dengan pendedahan daripada 50% keamatan cahaya boleh meningkatkan kesuburan tanah BRIS dan pengeluaran tumbuhan. Di sebaliknya, nilai pH tanah didapati sedikit berasid kepada berasid.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

Al	Aluminium
BRIS	Beach Ridges Interspersed with Swales
Ca	Calcium
CEC	Cation Exchange Capacity
cm	centimetre
Cu	Copper
Fe	Iron
g	gram
ha	hectare
K	Potassium
Kg	kilogram
ml	millilitre
mm	millimetre
Mn	Manganese
N	Nitrogen
Ni	Nickel
P	Phosphorus
XRF	X-Ray Fluorescence
Zn	Zinc

LIST OF SYMBOL

°C	degree Celsius
%	percentage
µm	micrometre

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Soil generally is defined as the material in the top layer of the surface of the earth in which plants can grow. It is a dynamic and multifunctional living system. According to Brevik *et al*., (2015) soil are derived from weathered parent materials and functions as supporting the growth performance of plants, habitat for living organisms, a regulator of water quality, and recycling system of nature. There are different properties in soil including soil texture, structure, water holding capacity and pH (whether the soils are acid and alkaline). All of these properties are combined together to make soils useful for a wide range of purposes (Ozores-Hampton *et al*., 2011). Bris soil is a type of sandy soil and has limited ability to support plant growth due to it poor of chemical and physical characteristic of soil (Laha *et al*., 2011). In this study, the type of BRIS (Beach Ridges Interspersed with Swales) soil from Bachok, Kelantan will be used. BRIS soil is choosen to promote the ability of this soil in agriculture system. This soil has a high percentage of sand that will prevent the growth of certain vegetative crops on that soil (Jahan *et al*., 2014). However, with good management practices, some of these crops will be grown with success and healthy. The crop production on the BRIS soil basically requires high fertilizer input and proper irrigation (Roslan *et al*., 2010). Thus, chemical fertilizer at proper rate will be applied on the Bris soil under different shading area to improve the fertility of BRIS soils.

According to Singh & Ryan (2015), the good fertility of soil is defined as the capacity of a soil to function within ecosystem and land uses boundaries, to maintain environmental quality, and promotes the plant and animal health. Soil fertility refers to the amount of nutrient in the soil, which is sufficient to support plant life. It is also critical in sustainable farming and need to be considered not only for crop productivity but also for the protection of aquatic environment (Robert, 2013). A fertile soil is usually rich in nitrogen, phosphorus, potassium, contains sufficient trace elements, soil organic matter that improves soil structure, and soil moisture retention. The NPK fertilizer will be used in this project as to maintain and increase the fertility status of the BRIS soil. Other than that, this fertilizer also will sustain the production of crop, improves soil health and enhances the nutrient use efficiency. This fertilizer is essential component to maintain good yield in the absence of sufficient organic and natural manure (Ayoola, 2006). The nutrients contained in NPK fertilizer are soluble in soil and available to the plants immediately. Thus, applying chemical fertilizer at the proper rate in soil can help to increase the fertility of BRIS soil.

According to Makus & Lester (2002), the amount of different light intensity exposed on soil also will affect the productivity of BRIS soil properties. Different shading area with 30% and 50% light intensity will be used as to study the effect of different amount of light intensity on BRIS soil properties and growth performance of groundnut. The amount of light intensity will be measured by using light meter as it is a device used to determine and to measure the amount of light that will be exposed direct to the plant and soil.

The good fertility of soil will produced a good yield in agro ecosystem. The seed of groundnut (*A. hypogaea*) will be planted on BRIS soils as to see how it grow with or without chemical fertilizer. The *A. hypogaea* is a groundnut in legume or bean family (*Fabaceae*). It is also known by several other names such as, peanuts, earthnuts and monkey nuts which are a legume that grows underground (Azam *et al*., 1990). Groundnuts are the best protein sources in the plant kingdom compared to other peas and beans. The groundnut seed is used for this experiment due to its ability to grow properly on the sandy soil. Besides, these seed is low cost compared to other vegetative crops and has high economic value in the market (Mathivanan *et al*., 2014).

Therefore, the fertility and productivity of BRIS soil which has disadvantage as a growth medium can be improved by a good management practices. The applying of chemical fertilizer with different shading area, 30% and 50% of light intensity can increase the amount of nutrient in soil in order will be used to successfully grow a number of certain plant species.

1.2 Problem Statement

BRIS soil is a problematic soil and it can cause low yields due to low fertility of soil, nutrient deficiencies, have low capacity of water holding, less ability to support the growth of plants, poorly structured and the soil temperature is relatively high. The high temperature will damage the survival of microorganism in soil and decrease the nutrient in soil. Besides, the large particle size of soil can cause the speedy vaporisation of moisture and nitrogen on soil surface. Thus, BRIS soil is not suitable to be used in agro ecosystem due to its poor physical and chemical characteristic. However, with good management practices and skill, some of the vegetative crops can be grown in this soil. Therefore, shading area with 30% and 50% light intensity and applying of chemical fertilizer with a proper rate on BRIS soil need to be studied. The proper amount of light intensity can decrease the soil temperature of Bris soil. This method also will increase the organic matter and nutrient in Bris soil. On the other hand, NPK fertilizer will be used to increase the productivity of BRIS soil due to its macronutrients which can help in plant growth performance.

1.3 Objectives

The purposes of the present study are;

1) To identify the effect of chemical fertilizer on BRIS soil properties under different shading area.
2) To study the effect of different amount of light intensity (30% and 50%) on soil properties of BRIS soil.

CHAPTER 2

LITERATURE REVIEW

2.1 BRIS soil

BRIS soil is known as sandy soil with high percentage of sand (82-99% sand particles) which result in very low of cation exchange capacity (CEC) and this will prevent the growth of plant (Roslan *et al*., 2010). Most of the sandy soil or BRIS soils in Peninsular Malaysia are found near the coastal area in Terengganu with area 67,852.61 hectare (ha), in Pahang around 36,017.17 ha, and in Kelantan about 17,806.20 ha (Armanto *et al*., 2013). The BRIS soil originates from sediment or sand from the sea that accumulated from the erosion of layer of steep cliffs by the sea during the monsoon seasons and has a coarse sand component.

According to (Roslan *et al*., 2011), the Department of Agriculture of Malaysia has identified and recommended seven types of BRIS soil namely Rusila, Rhu Tapai, Rompin, Rudua, Baging, Jambu and Merchang. These types of BRIS soil are defined by their profile morphology and chemical properties. Other than that, these types of BRIS soil are classified into two orders, which are Entisol and Spodosol. Entisol is defined as a young soil that can be found near the sea without a podog6enetic horizon and has high sand content while Spodosol as shown in Figure 2.1 is acidic soil with a sandy texture but unstructured with acidic humus content.

There have several characteristics of BRIS soil which are drain well, lack of water holding, low fertility and having a relative high soil temperature. It is one of the problematic soils because of it nutrients are not uncommitted in many aspect (Toriman *et al*., 2009). The large in particles size of soil causes the nutrients in the soils are washed out quickly. Therefore, this soil is categorized as unsuitable soil for the cultivation in their natural state due to it low fertility of soil properties.

Figure 2.1: Spodosol soils formed in sandy materials, under climates where large amounts of water infiltrate into the soil at one or more times of the year.

Sources: http://www.nature.com/

2.2 Chemical Fertilizer

Fertilizers are defined as a compound that spread on into soil to increase its capacity to support plant growth. Fertilizers are food that needed by the plant and is one of the important components during the process of plant growth. The application of fertilizer is required to replace crop land nutrients that had been used by previous plant growth with the ultimate goal of maximizing productivity and economic returns. Fertilization increases efficiency and obtains better quality of product recovery in agricultural activities (Savci, 2012).

According to Nidhi *et al.*, (2014) increased crop production largely depends on the type of fertilizers used to supplement essential nutrients for plants. The fertilizer can be classified into two categories, organic and inorganic fertilizer. Organic fertilizer can be defined as composed of bio-matter or those that originated in a living organism such as a plant or an animal while inorganic fertilizer is a synthetic fertilizer and various chemical treatments are required for their manufacture.

Most commercially available fertilizer is inorganic fertilizer and it is normally used by the farmer to improve the soil fertility and increase crop yields in agro ecosystem. According to Havlin, (2005) this chemical fertilizer that are used is the manufactured fertilizers contains Nitrogen (N), Phosphorous (P) and Potassium (K) which are needed by the plant to growth properly. The function of Nitrogen (N) is to help plant leaves to grow properly, synthesizes amino acids which in turn form protein and regulates the uptake of other nutrients while Potassium (K) is for plant health as it will strengthens cell walls, essential to the formation and translocation of protein, starches, sugar and oil–improving the size and quality of fruit, grains and tubers. The Phosphorous (P) will help in the development of roots and flowers, increases the ratio of grain to straw, and also increases resistance to disease. All of these minerals are referred as primary or macronutrients.

However, these elements must be obtained by the plants for their growth, other than carbon, oxygen and hydrogen from soil. The continuous use of this fertilizer in proper rate on soil will provide the valuable during cropping period and after harvesting (Dubey *et al*., 2012). Hence, the application of chemical fertilizer on agricultural land not only improves the fertility of soil but also provides a good survival of organisms in the soil.

2.3 Shading area

Shade is not only influences the amount of light received by plants but also changes other macro environmental conditions, such as air and ground temperature. It is also effects the survival of microorganism in soil. Shading the area can help in creating a more favourable understory environment. Most of the herbs, shrubs and saplings require a cool environment to grow successfully. Shade also reduces the rate of soil moisture evaporation and can decrease the temperature of soil properties

According to the Stanton *et al*., (2010), all the plant growth parameters such as plant height, number of leaves and its branches were reduced in over shading area due to the lack exposes of light intensity. The adaptation of most vegetative crops is in the range of 60% to 80% of shading area (Robert, 2013). Furthermore, he stated that these conditions also assure a high biological activity and it is important to achieve the benefits of organic matter by increasing the fertility of

BRIS soil. Thus, it is expected that the groundnut plant will adapted well based on more nutrients provided by soil microorganism in 50% of shaded conditions.

2.4 *Arachis hypogaea L.*

Arachis hypogaea L. as shown in Figure 2.4 is the world's most popular oil seed crops which are grown as an annual plant (Farag & Zahran, 2014). They stated that *A. hypogaea* is very important to both human and animals, and the high oil and protein content in the groundnut make it an important food crop. It is widely grown in the tropical region of world on sandy soils and being important to both smallholder and large commercial producer. This crop species are high of monounsaturated fat. They also contain magnesium, foliate, vitamin E, copper, and fibre that necessary for normal human growth and maintenance (Martinson, 2009). *A. hypogaea* not only has high economic and nutritional potential but also is an important cash crop for the farmer in poor tropical countries (Shiyam, 2010).

According to Martinson (2009), a good environmental condition during the vegetative period of growth encourages the proper development of seed. The factors that will affect the germination of *A. hypogaea* seed are light, temperature, soil moisture content and seed viability. The best temperatures of soil for the growing of *A. hypogaea* are in range from 25°C to 35°C with pH range of 5.3 to 7.3. *A. hypogaea* usually grow well in light sandy to sandy-loam, well-drained, aerated soil and are suitable to be planted on the soil that has low clay content (less than 20%) to avoid the pegs of the *A. hypogaea* break at harvest. Thus, sandy soils are the best soil for *A. hypogaea* to growth optimally.

Figure 2.2: The seeds of *A. hypogaea*

Source by: http://www.21food.com/products/groundnut-seed-232394.html

2.5 Light intensity for plant and soil

The light, soil nutrition and water have been considered as the three main factors affecting plant growth. According to Zhao *et al*., (2012), the soil nutrition and water are relatively easy to control through fertilization and irrigation, but light is more difficult to control. Among the main environmental factors in agricultural system, light intensity is the most important one that regulates the process of photosynthesis, the plant survival, growth and adaptation (Zervoudakis *et al*., 2012). It is an essential factor in maintaining plants.

In this case, light intensity can be defined as the total amount of light that plants receive. It is also can be described as the degree of brightness that a plant is exposed to. The amount of natural light that receive by the plants is affected by several factors such as the presence of trees and shrubs. The growth performance of plant either active or passive is depends on the amount of light it receive (Neri *et al*., 2003). Light plays a critical role in plant growth and development, both quantity and quality, as well as direction of light is perceived by photo sensory systems which, regulate plant development and maintain photosynthetic efficiency.

Furthermore, light intensity that exposed directly to the soil will affect their fertility and productivity of soil properties. The high amount of light that exposed to the soil will damage the survival of bacteria in soil and decrease the process of decomposition in soil. Decomposition can be defined as the breakdown of plant and animal residue into different organic and inorganic compound (Martin, 2010). Soil microorganism plays a critical role in maintenance and increasing the fertility and productivity of soil. They control soil chemical reactions and decompose organic matter into humus, which again helps with aggregate stability. Soil organisms decompose organic matter more quickly under warm and moist condition than under cold or dry condition. Soil temperature and moisture content are very important factors affecting decomposition rates. The high amount of light intensity increase the temperature and decrease the moisture content in soil properties which may severely reduce decomposition rates. Thus, it will decrease the fertility and productivity of soil.

2.6 Soil Properties

Soil is a natural body that contain minerals and rock, decaying organic matter, microorganism, insects, nutrients, water, and air. According to Chaudhari *et al*. (2013), soil plays a vital role in the Earth's ecosystem. Soil provides plants with foothold for their roots and holds the necessary nutrients for plants to grow, filters the rainwater and regulates the discharge of excess rainwater and also provides physical support for both plants and animals including humans and the structures they build. Soil functions are general capabilities of soils that are important for various agricultural, environmental, nature protection, landscape architecture and urban applications

According to McCauley *et al*. (2005), there are three main ways in which soil are formed which are mechanical, chemical and biological weathering process. All the process is working at the same time to break down rocks. Mechanical weathering breaks rocks into smaller pieces and this process is called as disintegration. Chemical weathering is the change of the mineral makeup of the rocks and this process is called as decomposition and the biological weathering describes any processes of disintegration or decomposition accomplished by living organism. The soil can be described and managed according to their texture, soil pH, and soil colour.

2.6.1 Soil Texture

Soil texture refers to the relative proportions of the various size groups of individual particles or grains in a soil (Osman, 2013). Soil texture is determined by the ratio of sand, silt and clay in the sample. These sand, silt and clay are mineral components of soils and are distinguished by particle size. Based on these different sizes, soil particles are classified as sand (0.05- 2mm), silt (0.002-0.5mm) and clay (less than 0,002mm). Soil texture is the most important physical property of the soil in terms of soil fertility because it influences several other soil properties including density, porosity, water and nutrient retention, rate of organic matter decomposition, infiltration and cation exchange capacity (Bhargavi, 2010).

According to Roslan *et al*. (2010), the texture of these soils is sand which results in very low cation exchange capacity. The particle size of sand is relatively large, which promote free drainage of water and entry of air into the soil (Bot & Benites, 2005). The implication of free drainage in sandy soil is that soil nutrients are easily washed down into the soil and become inaccessible to be used by plant. Sandy soils are considered non-cohesive and because of their large size, have low specific surface areas and thus have low nutrient retention capacity.

2.6.2 Soil pH

Soil pH is an important soil property that affects several soil reactions and processes and is defined as a measure of the acidity or alkalinity of the soil. It has considerable effect on soil processes including ion exchange reactions and nutrient availability. Soil pH is measured on a scale of 0 to 14, where a pH of 7.0 is considered neutral, readings higher than 7.0 are alkaline, and readings lower than 7.0 are considered acidic (McCauley *et al*., 2009). Soil pH is one of the most important characteristics of soil fertility, because it has a direct impact on nutrient availability and plant growth. Most nutrients are more soluble in acid soils than in neutral or slightly alkaline soils. The pH of a soil will affect so many other soil properties, including nutrient availability, effects on soil organisms and cation exchange capacity and plant preferences of either acidic or alkaline soils. Most plants prefer alkaline soils, but there are a few which need acidic soils and will die if placed in an alkaline environment.

2.6.3 Soil Colour

Colour is one of the most obvious and often the most significant characteristic of the soil and is very apparent in the horizons of a soil profile. Surface colour which differs from that of the parent material as shown in Figure 2.3 is usually a reflection of the processes operative during soil formation and may also indicate other factors such as excess salinity or erosion (Saporetti-Junior *et al*., 2011). Organic matter, manganese and iron are the primary colouring agents in soil. Soil colour also is influenced by the amount of proteins present in the soil. Subsoil colours are classified as red, yellow, brown, or grey.

The dark colour of topsoil usually indicates presence of organic matter. Light or pale colours on the surface soil are frequently associated with relatively coarse texture, highly leached conditions and high annual temperature. Light coloured soils generally are low in organic matter content, high in sand particles, or contain reduced iron or manganese oxide.

According to Roslan *et al* (2010) sandy soil as shown in Figure 2.4 is lighter in colour than other soil due to low in nutrient and organic matter. BRIS soil has large particle size that will cause the speedy vaporization of moisture and nitrogen on soil surface.

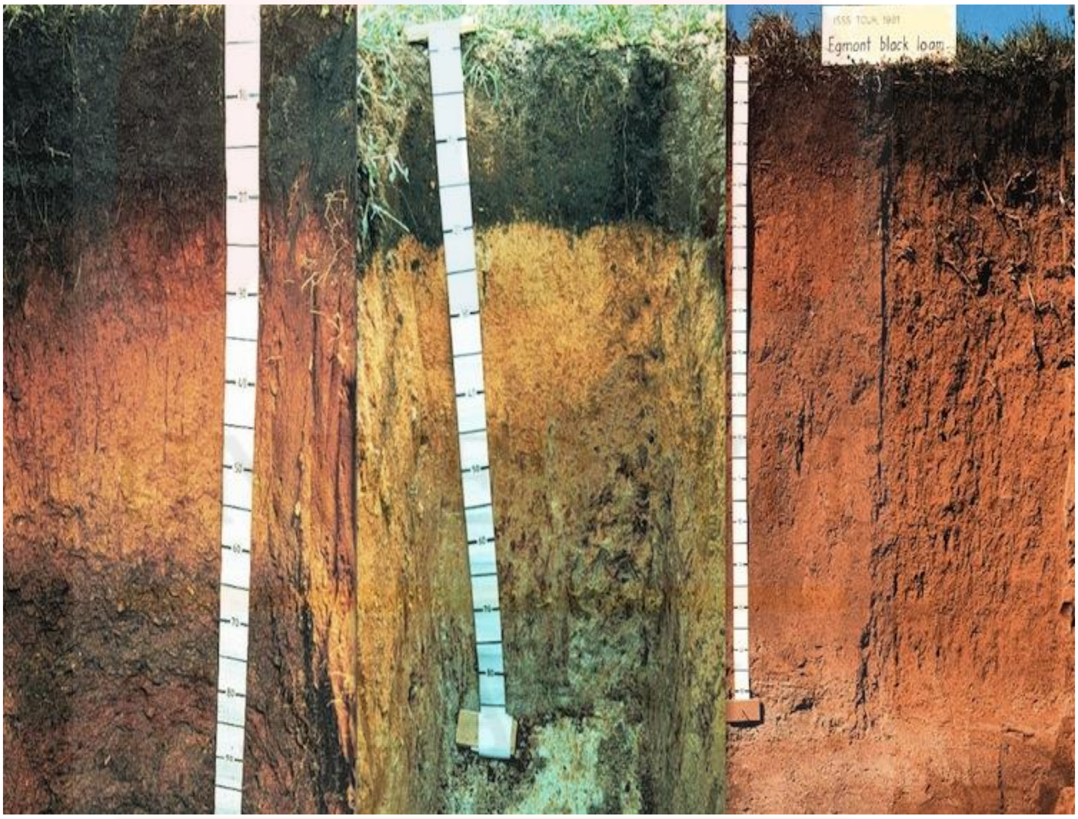

Figure 2.3: The soil colours of soil are not all the same.

Source by: http://sciencelearn.org.nz/ Contexts/ Soil-Farming-and-Science/

Figure 2.4: The color of BRIS soil.
BRIS soil from Universiti Malaysia Kelantan campus Bachok showed the colour of soil is lighter than other soil due to low in nutrient and organic matter.

CHAPTER 3

MATERIALS AND METHODS

3.1 Material and apparatus

During the experiment, there were some material and tools were used in order to help in obtaining data and information about the project. All of the materials are:

Gardening tools:

BRIS soil, 40 of groundnut seeds, 40 gram of NPK fertilizer, gardening gloves, 20 cm x 8 cm black polybag, trowel, hand fork, paranet, light meter, siever size 75 µm, hose pipes, PVC pipe, plastic mulch film, wheelbarrow, barb wire fence, and pesticide, digital calliper.

Laboratory tools:

pH meter, crucible lid, hot plate, soil tester, distilled water, Beaker, Weight Balance, measuring cylinder, Boiling Tube, Erlenmeyer Flask, Whatman Filter, Mechanical Shaker, siever machine, 50ml Volumetric Flask, Syringe, X-Ray Fluorescence (XRF).

3.2 Methods

3.2.1 Study site

The experiment was conducted at Agropark, Universiti Malaysia Kelantan (UMK) Jeli Campus. The plastic mulch filmwas applied as to avoid the growth of grass on that experimental site. The artificial shading area with 30% and 50% of light intensity were prepared by using paranet. The light meter was used as to measure the percentage amount of light intensity as shown in Figure 3.1. The chemical fertilizer, BRIS soil and a good quality of *A. hypogaea* seeds were used for the experiment for two months. A 2x2 factorial experiment was carried out. The factors involved were shown in Table 3.1 below.

Table 3.1: Preparation site for *A. hypogaea* crop

Type of soil / Light Intensity	BRIS Soil	BRIS soil with chemical fertilizer
30%	10 seeds of groundnut	10 seeds of groundnut
50%	10 seeds of groundnut	10 seeds of groundnut

3.2.2 Soil sample and pre-treatment

The BRIS soils were collected from Bachok, Kelantan. The *A. hypogaea* seeds and all the materials and tools were bought from local agriculture shop. The seeds then were submerged first in the distilled water for a day in order to eliminate skinned, immature and less quality of seed. Black polybags in size of 20 cm x 8 cm were filled with the different media of soil, Bris soil with and without NPK fertilizer. These polybags were placed under two different amounts of light intensities. Shades areas were constructed by paranet as shown in Figure

3.2 for 30% and 50% of light intensity. There were four treatments and each treatment consists of five polybags with two seeds in each bag and the experiment for each treatment was replicated five times. Total number of the *A. hypogaea* seeds required was 40. This experiment was laid out in split plot design. Watering was carried out twice a day, in the morning and evening. The NPK fertilizer (1 gram) was applied every two week in two months. The pesticides were applied when necessary.

Figure 3.1: Light meter to measure the percentage amount of light intensity

Figure 3.2: Shading area by using paranet.

3.2.3 Determination of performance growth on groundnut

The performance growth of *A. hypogaea* was observed every week. The height of *A. hypogaea* was measured from soil level to the highest shoot by using a ruler. The diameter of groundnut stem then was measured using digital callipers. The initial and final height and stem diameter of *A. hypogaea* tree were recorded.

3.2.4 Monitoring BRIS soil properties

The soils sample was taken from each polybag (0-15 cm depth) for both experimental sites before planting to identify the pure of physical and chemical properties of BRIS soil. The observations were measured every two weeks and the soil samples from each treatment were taken again to identify the effect of chemical fertilizer on BRIS soil properties. The next step, soil samples were dried in oven for 48 hours at temperature of 105ºC (Wilke, 2005). The dried soils were sieved through a ≤2.0 mm to break up larger aggregates. The soil samples then were tested and analysed due to its physical and chemical properties and all the data were recorded.

3.3.5 Physical properties testing

The physical properties of soil were measured due to its colour, temperature, soil texture and the soil moisture content. The colour of soil were determined by using Munsell Color System and the temperature of soil by using pH meter as shown in Figure 3.3 The texture of soil will be tested according to the soil composition and moisture content by soil tester. BRIS soil (100 gram) will be put into a beaker and filled with 250ml of distilled water and were shaking about 15 minutes. The contents then was poured into 1 L of measuring cylinder and filled full with distilled water. The measuring cylinder then were not be disturbed for 24 hours. The depth of three different layers as shown in Figure 3.4 were measured and it percentage was recorded.

Figure 3.3: pH meter as measure the temperature of soil

Figure 3.4: Different layer of soil

3.2.6 Chemical properties testing

For chemical properties, the soil samples tested were pH, heavy metal and organic matter in the soil. The pH values of soils were tested by using the soil tester as shown in Figure 3.5. Besides, for soil heavy metal, 200g of dried soil of each treatment were sieve under size 75 µm by using siever machine. The soils then were weighed for 15 gram then were be ruined by X-Ray Fluorescence (XRF) machine.

Figure 3.5: soil tester was used as to measure the soil moisture and pH.

As to determine the percentage of organic matter in soil, it was measured by combustion process. The mass of empty porcelain dish and soil samples were recorded, and then heat it in 105ºC temperature. The fume was allowed during the combustion process until there were no visible fumes. Lastly, the samples were reweighed again and the percentages of soil organic matter were calculated. All of these methods were repeated every two weeks. The percentages of soil organic were analysed using the formula shown below:

1. Mass of dry soil Eq: 1

   $M_D = M_{pds} - M_P$

2. Mass of burned soil Eq: 2

   $M_A = M_{PA} - M_P$

3. Mass or organic matter Eq: 3

   $M_O = M_D - M_A$

4. Organic matter content Eq: 4

   $OM = (M_O / M_D) X 100$

Where:

Mp = Mass of empty porcelain dish

Mpds = Mass of soil and porcelain dish

M_{PA} = Mass of burned soil

3.2.7 Flow chart of methodology

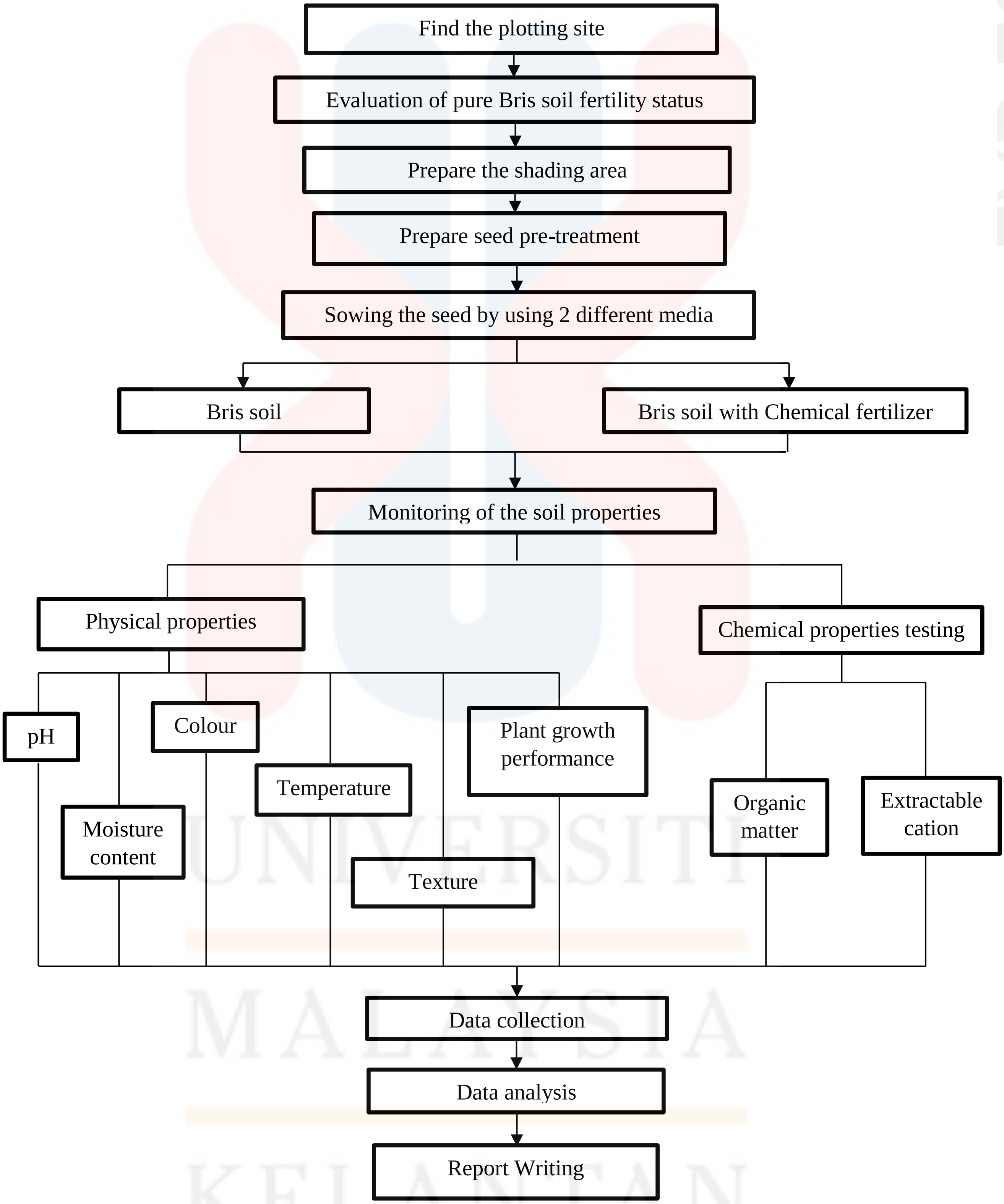

Figure A. 1: Flow chart of methodology

CHAPTER 4

RESULTS AND DISCUSSIONS

Chemical fertilizers are manmade soil enhancers used to raise the level of nutrients found in the soil which essential for plant to growth properly. At the end of the project, the results showed that applying of chemical fertilizer increased the performance growth of groundnut plants and increase the fertility of BRIS soil.

4.1 The type of soil texture for BRIS soil.

The texture of soils was measured to identify the type of soil texture for soil with and without applying of chemical fertilizer under 30% and 50% of different light intensity. Based on analyzed soil samples, there is less change between the soil textures before and after applying of chemical fertilizer for two months. It could be attributed that the period for the project are not enough for soil to change their texture. Soils develop slowly over time and are composed of many different materials (Reed *et al.*, 2000).

At the end of the experiment, the result recorded that the texture type of BRIS soil for all treatments under different light intensity was found as sandy soil as shown in Figure 4.1 with the percentages of sand: 85–100%, silt: 0–15% and clay: 0–10%. The sandy soil allows water to drain right through and does not have the ability to hold onto many nutrients (Bhattacharyya *et al.*, 2008).

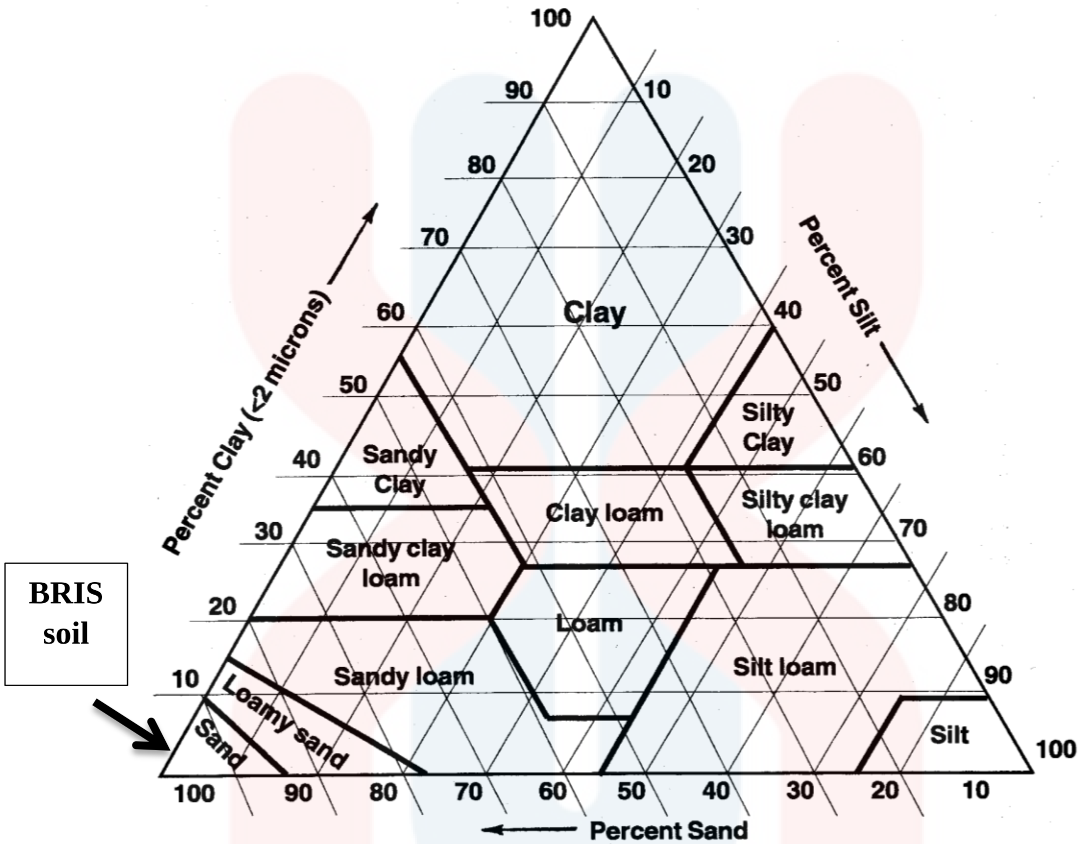

Figure 4.1: Textural triangle showing a soil's textural class according to the percentage of sand, silt and clay it contains.

Source by: http://passel.unl.edu/pages/informationmodule

4.2 Soil color of BRIS soils.

Table 4.1 showed the color of BRIS soil with and without chemical fertilizer under different light intensity. The result showed different colors of soil with different sites sample.

Table 4.1: The color of soil for different treatment under different light intensity.

Soil Treatments	Color Of Soil
Pure BRIS soil	Light gray 10YR
30% light intensity: BRIS soil	Light gray 10YR
30% light intensity: BRIS soil with fertilizer	Light gray 10YR
50% light intensity: BRIS soil	Gray 10YR
50% light intensity: BRIS soil with fertilizer	Gray 10YR

Color is perhaps the most obvious and easily determined soil characteristic. It is an indirect measure of such things as the amount and distribution of organic matter in the soil, and the state or degree of soil aeration (Wright & Sautter, 1979). The soils that are high in organic matters and nutrients are dark brown or black and soil that drains well is brightly colored. Based on the result showed in Table 4.1, the soil color for BRIS soil after experiment were found to be light gray to gray color. The color for BRIS soil with fertilizer and without fertilizer under 50% of light intensity is darker compared to the color of soils under 30% of light intensity. This color change could be attributed by the increases amount of nutrient in soil by application of chemical fertilizer. Besides, the presence of soil organic matter also has an effect on soil color, usually making it darker.

4.3 Temperature of BRIS soil.

The temperatures of BRIS soils were measured for eight weeks as to identify the effect of chemical fertilizer on BRIS soil properties. The over range of soil temperature for all treatments are from 24 ºC to 35 ºC.

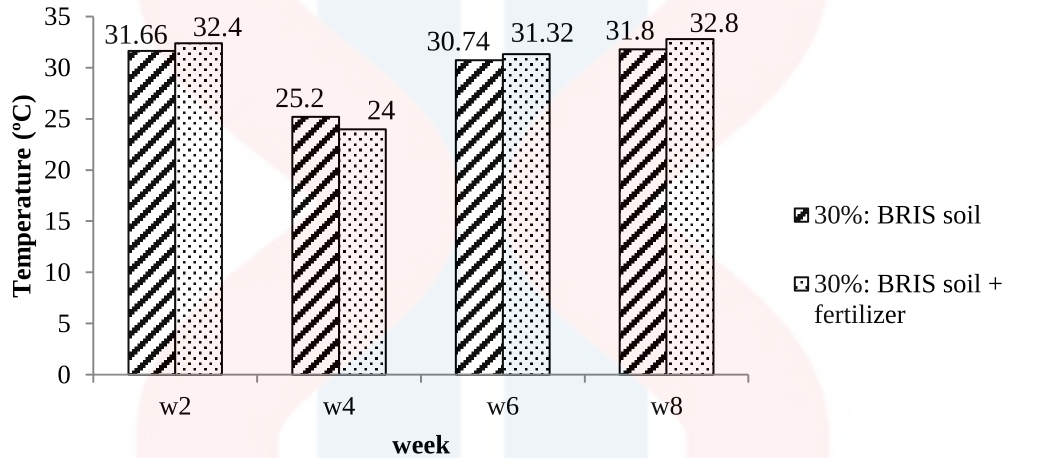

Figure 4.2: The temperature of soil in different type of soil under light intensity (30%)

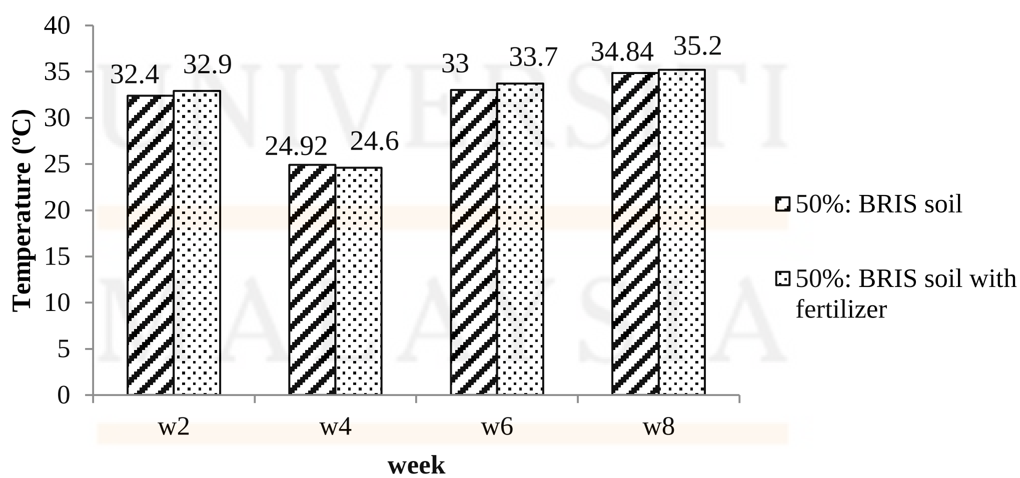

Figure 4.3: The temperature of soil in different type of soil under light intensity (50%)

In Figure 4.2 and 4.3, the graph showed that all the treatments for both sites on week 4 have lowest average of soil temperature and it could be attributed that he soils absorbed more water from rainfall which tend to decrease the soil temperature.

The highest temperature of 35.2 ºC was measured at soil site under 50% of light intensity and the lower of 24 ºC was occurred at site under 30% of light intensity**.** The highest temperature of 35.2 ºC was measured at soil site under 50% of light intensity and the lower of 24 ºC was occurred at site under 30% of light intensity. The highest soil temperatures were detected on BRIS soil that applied chemical fertilizer and the lowest at BRIS soil without fertilizer. Besides, large amount exposed of light intensity on soil will increase the soil temperature and less exposes make the soil in low temperature.

The overall result showed that the soils under 50% of light intensity can increase the fertility and productivity of BRIS soil. Besides, the soil under 50% light intensity produced high amounts of organic matter. According to Kononova (2013), the soil microbial activity and decaying process increase with increasing temperature and high amount of organic matter can improves the fertility of soil which increase soil’s ability to take up and hold water.

4.4 The average soil pH value of BRIS soil.

According to Singh & Ryan (2015), soil pH affects all the physical, biological and chemical soil properties and the growth of specific organisms, and microbial activity. In this research, it is shown that the range of the soil pH throughout all the treatments is from 5.02 to 5.97. Table 4.2 shows the average of soil pH in each treatment.

Table 4.2: Average soil pH value for each sampling station

Week	Average soil pH			
	30%: BRIS soil	30%: BRIS soil with chemical fertilizer	50%: BRIS soil	50%: BRIS soil with chemical fertilizer
2	5.96	5.81	5.97	5.95
4	6.53	6.52	6.53	6.52
6	5.16	5.16	5.15	5.14
8	5.02	5.02	5.04	5.04

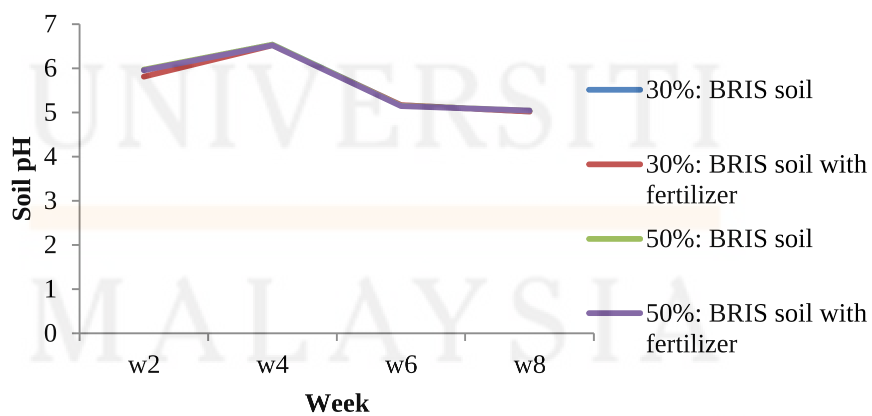

Figure 4.4: The pattern of pH value showed that the soils for all treatment were found to be slightly acidic to acidic.

The acidity of any soil varies according to the type of parent material, the length of time it has weathered and the local climate. As a result some soils can be naturally very acidic and some soils can be much more alkaline (Bolland *et al.*, 2004). Based on pH values for the eight weeks of experiment, both soil sites at different light intensity (30% and 50%) were found to be slightly acidic to acidic as shown in Figure 4.4 Moreover, the result showed there is less significant difference between soil pH at BRIS soil with and without fertilizer.

Table 4.2 showed the higher average pH value of BRIS soil for both sites was identified on week 4 and the lower average pH value was on week 8. The higher soil pH could be attributed by absorbing of more water from heavy rainfall that neutralizes the soil pH value. The lower pH value is due to absorption of base nutrients by growing plants and soil processes, including nutrient availability and microbial activity. Besides, the presence of high content of organic matter in the soil can be another factor for lowering of the pH (Ashraf *et al.*, 2012). According to Robert (2013), the high levels of organic matter result in a greater number of cation exchange which able to decrease the pH value of soil.

Apart from that, leaching of nitrogen in nitrate form can decrease the soil pH value then increasing in soil acidity. The nitrate is a major nutrient for plant to growth and this nitrate can be supplied either from nitrogenous fertilizer that applied on BRIS soil or from atmospheric nitrogen fixed by legumes (Schulz *et al.*, 2013). Thus, the leaves of nitrates from uptake by plant will drains below the plants roots and into the ground water system then make soil more acidic.

4.5 Moisture content of BRIS soil.

Soil moisture was measured in soil from week 2 until 8 to justify either addition of chemical fertilizer to BRIS soil under different light intensity (30% and 50%) affects the soil moisture. The graph below showed the amount of soil moisture content in different sites.

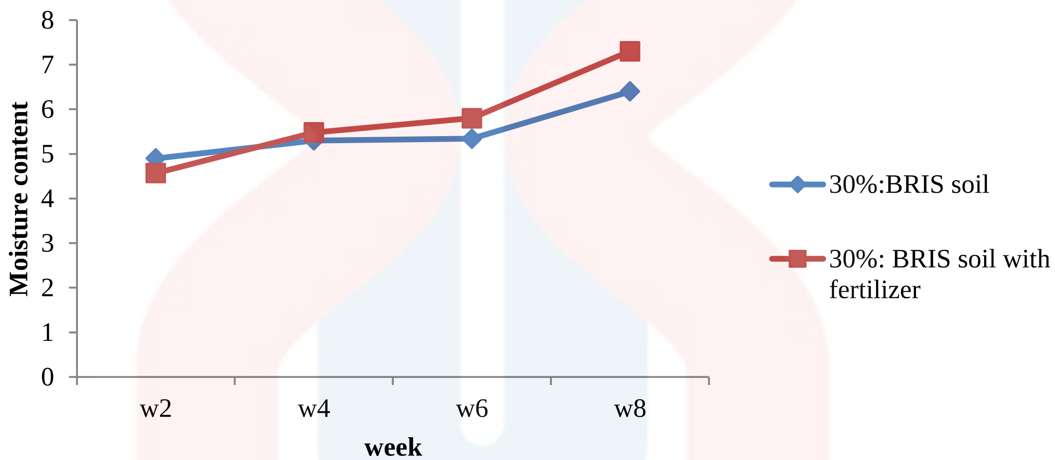

Figure 4.5: The soil moisture content of BRIS soil and BRIS soil with fertilizer under 30% light intensity

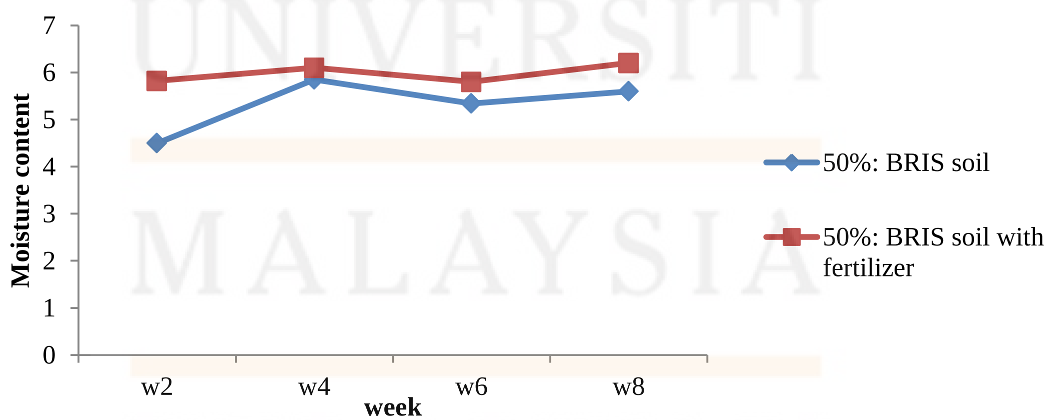

Figure 4.6: The soil moisture content of BRIS soil and BRIS soil with fertilizer under 50% light intensity

Based on the result for two months, the maximum value of soil moisture content was recorded at BRIS soil with chemical fertilizer under 30% of light intensity in week 8th as shown in figure 4.5 while the minimum value was found at BRIS soil under 50% of light intensity in week 2nd as shown in Figure 4.6. The highest value of soil moisture content could be attribute to the less amount of light intensity (30%) being received at the surface and consequently less evaporation of the soil moisture. The lowest value of soil moisture content could be due to the reason that lot of evaporation takes place from the exposed of 50% light intensity.

Throughout the experiment, the soil moisture content for all the treatments keep changing week to week due to the BRIS soil having low water retention capacity, limited ability to support plant growth and having a relatively high soil temperature (Toriman *et al*., 2009). The increase amount of soil moisture could be attributing by the absorption of water from heavy rainwater. The soils absorb more water and increasing the soil moisture content.

4.6 Organic matter of BRIS soil.

The graph below showed the amount of organic matter in BRIS soil with and without applying of chemical fertilizer under different amount of light intensity. It was measured as to identify the best situation in order to improve the amount of soil organic matter.

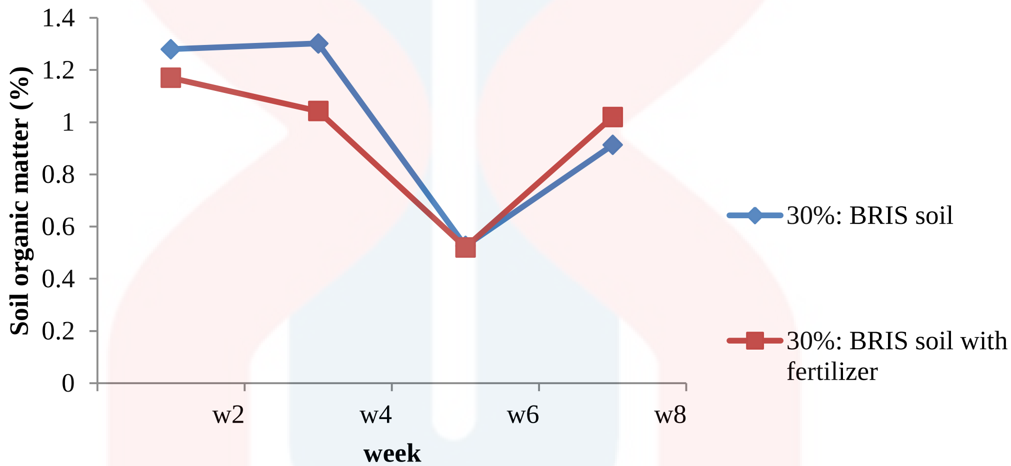

Figure 4.7: The percentage of soil organic matter under 30% light intensity

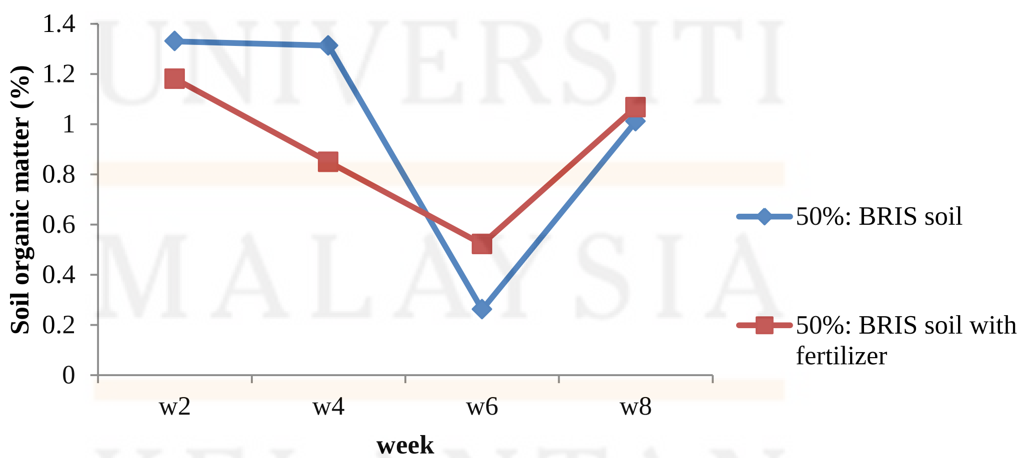

Figure 4.8: The percentage of soil organic matter under 50% light intensity

Based on the graph showed in Figure 4.7 and 4.8, the percentage of organic matter for both BRIS soil with fertilizer and without fertilizer under 30% and 50% light intensity are decreased from week 2nd to week 6th then increased in week 8th. The decreases of organic matter for both types of soils could be attributing to the process of plant growth. According Bot & Benites (2005), the declined of soil organic matter can cause by leaching and soil erosion, and also can be uptake by plant for plant development.

The result showed that the percentage of soil organic matter at the end of the experiment is higher in BRIS soil with fertilizer compared to the BRIS soil without fertilizer. The increasing of organic matter can be influence by decomposition of soil microorganisms and decaying of falling leaves from groundnut plants, which make the fertility of soil increased. Besides, applying of chemical fertilizer on BRIS soil also increased the amount of soil organic matter. According to Bierman & Rosen, (2005), the use of some fertilizers, especially N fertilizers, can boost micro-organism activity which will increase the amount of organic matter in soil.

Besides, the average percentage of soil organic matter under 50% light intensity higher than soil organic matter under 30% light intensity. It is because soil temperature under 50% light intensity are more suitable for microbial activity and decompose of organic matter. According to Cattanio (2008), organic matters decompose faster in humidity condition and well aerated soil.

4.7 Heavy metal in BRIS soil.

The table showed the presence of metals in BRIS soil with and without chemical fertilizer under different amount of light intensity. The result was compared between the metals in BRIS soil before and after experiment.

Table 4.3: The presence of metals in soil samples for different treatment under different light intensity.

	Soil Treatments				
	P	T1	T2	T3	T4
Metal	Concentration (%)				
Al	15.4	17.6	17.1	18.3	17.9
Fe	9.65	10.5	8.68	10.3	10.2
K	7.91	8.96	9.64	7.8	9.83
Ca	6.31	1.03	1.46	1.23	2.57
P	-	0.735	1.5	-	1.41

Where, P: Pure BRIS soil

T1: BRIS soil under 30% light intensity

T2: BRIS soil with fertilizer under 30% light intensity

T3: BRIS soil under 50% light intensity

T4: BRIS soil with fertilizer under 50% light intensity

The result showed the small quantities of minerals were found in both sites of BRIS soil with and without chemical fertilizer as shown in Table 4.3. Studies found out that the content of the main nutrients in BRIS soil, that is, nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg) and calcium (Ca), is low (Toriman *et al.,* 2009). This is due to the sandy structure of the soil which causes rapid leaching of these nutrients. The metals of zinc (Fe) and Aluminium (Al) are the highest metals found in all soil samples under 30% and 50% light intensity due to the high acidity of soil. According to Halcomb *et al.,* (2009), metals (Cu, Fe, Mn, Ni, and Zn) are very tightly bound to the soil at high pH and are therefore more available at low pH levels than high pH levels. The result showed that amount of calcium (Ca) in soils for both sites was decreased. The calcium was essential for nut development in peanuts (Harris & Henry, 1949). Besides, the amount of potassium (K) and phosphorus (P) showed higher in BRIS soil with fertilizer compared to the BRIS soil without fertilizer. It could be supplied by the applying of chemical fertilizer on BRIS soil.

4.8 Height and diameter of *Arachis hypogaea*.

The height and diameter of groundnut plants were measured as to identify their growth performance according to the different type of media and different amount of light intensity. The graph in figure 4.9 and 4.10 showed the height of groundnut plants in two months experiment.

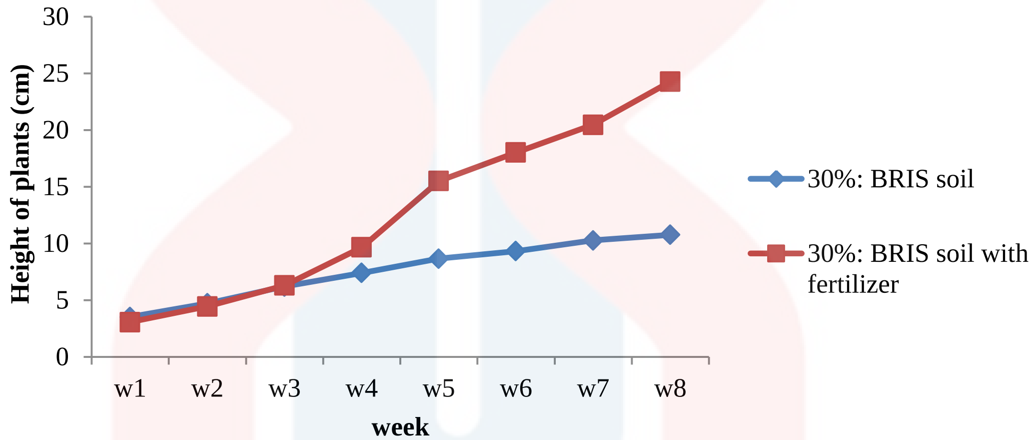

Figure 4.9: Height of plants under 30% light intensity

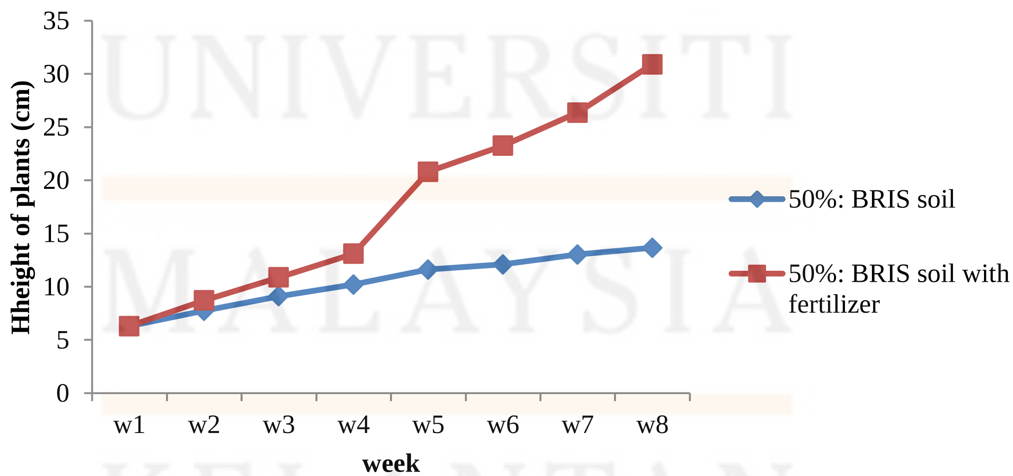

Figure 4.10: Height of plants under 50% light intensity

The graph in figure 4.11 and 4.12 showed the diameter of stem of groundnut plant in two months experiment.

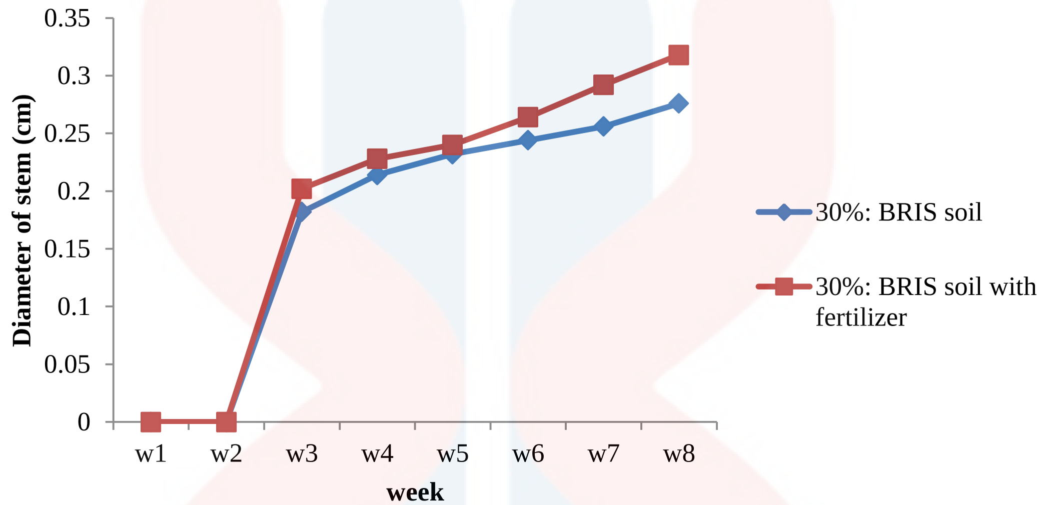

Figure 4.11: Diameter of stem under 30% light intensity

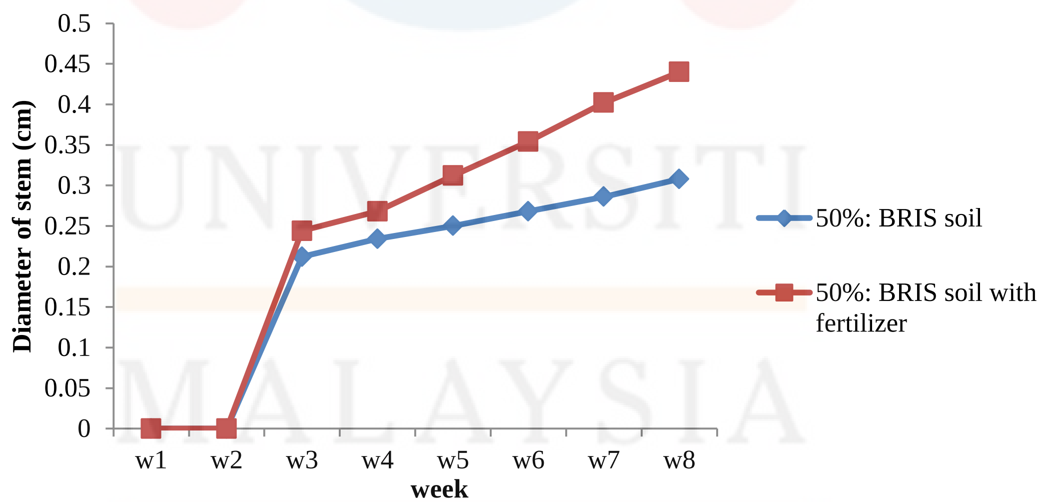

Figure 4.12: Diameter of stem under 50% light intensity

The result presented that height and the diameter of groundnut plants were significantly increased in both soil sites under 50% and 30% light intensity. The height and diameter of plants for both sites increased rapidly at BRIS soil with chemical fertilizer compared to the BRIS soil without fertilizer as shown in Figure 4.9, 4.10, 4.11 and 4.12. The applying of chemical fertilizer on BRIS soil could increase the nutrient and improved fertility of soil. According to Havlin (2005), chemical fertilizers are an essential component of any system in which the aim is to maintain good yield in the absence of sufficient organic and natural manure in soil. Presence and balancing of nutrients in chemical fertilizer led to the development of plant growth (Adediran *et al.*, 2004)

The height and diameter of plants were least in BRIS soil without chemical fertilizer. It is because the plants had to use the limited nutrients that the soil could supply without any external inputs. This shows that the use of chemical fertilizers in balanced amount will increase the productivity of groundnut plants. Besides, the sufficient of light intensity also affected the growth performance of groundnuts plant. The graph showed that the height and diameter of groundnut plant were more effective at soil which exposed of 50% light intensity compared to the 30% of light intensity. According to Zervoudakis, *et al.*, (2012), an increase in light intensity will produce an increase in the rate of photosynthesis thus increased the productivity of plants.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

BRIS soil which is poor in physical and chemical properties as well as low in fertility can be improved by applying proper amount of chemical fertilizer. In conclusion, the study showed that application of 40 gram of chemical fertilizer in two months was very effective for increasing the fertility of BRIS soil and growth performance of *Arachis hypogaea L.* at the end of the research. Besides, the balance amount of light intensity and shading area received by the soil also increased the amount of soil organic matter in order to improve the fertility of BRIS soil. The overall result showed that, the application of chemical fertilizer and the effect of 50% of light intensity can increase the fertility and productivity of BRIS soil. The both of the objectives for this present study were achieved.

At the end of the project, the pH level of BRIS soil under different light intensity (30% and 50%) was found to be slightly acidic to acidic. In order to increase soil pH to the desired level, it is recommended to apply the liming material on BRIS soil. The addition of lime material on BRIS soil not only replaces hydrogen ions in soil and raise the soil pH, but it also provide two calcium and magnesium to the soil. Besides, the use of organic inputs also can be applied to increase soil physical and chemical properties of BRIS soil. According to Taguiling (2013), the applying of animal manures or compost will gradually improve the level of organic matter in soil as well as providing valuable nutrient for plant to growth. Lastly, BRIS soil can be commercialised to the farmer outside so that it can be used in agricultural system.

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APPENDICES

Figure A. 2: The BRIS soil were collected from Bachok, Kelantan

Figure A. 3: Shades area were constructed by paranet

Figure A. 4: Seed of *Arachis hypogaea L.* soaked in water in a day

Figure A. 5: Seed germination of *Arachis hypogaea L.*

Figure A. 6: Planting sites.

Figure A. 7: The auto sieve shaker to sieve the soil sample

Figure A. 8: The combustion process to measure soil organic matter.