THE EFFECT OF CHEMICAL FERTILIZER ON GROWTH PERFORMANCES OF *Arachis hypogaea* UNDER TWO LIGHT INTENSITY ON BRIS SOIL.

By

NUR HAMIZAH BT CHE MOHD ARIFFIN

A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with Honours.

FACULTY OF EARTH SCIENCES

UNIVERSITI MALAYSIA KELANTAN

2017

DECLARATION

I declare that this thesis entitled "The effect of chemical fertilizer n growth performances of *Arachis hypogaea* under two light intensity 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.

Signature : ________________________________

Name : ________________________________

Date : ________________________________

ACKNOWLEDGEMENT

In the name of Allah, the most gracious and the most merciful, first and for most, I would like to thank Allah because provided strength and perseverance in accomplishing this thesis. Firstly, I would like to express my deepest gratitude and appreciation to my supervisor, Dr. Sitti Fatimah bt Mhd Ramle for the guidance, constructive, encouragement and support throughout this research.

Many thanks go out to Universiti Malaysia Kelantan especially Faculty of Earth Science for the research facilities that are provided and for giving me the opportunity to carry out this research. Special thanks to the supplier that supply groundnut seeds and black net for this research. Credits to the laboratory staff that always lend a hand in this research.

Finally, I would like to deliver my greatest appreciation to my family for always believing and supporting me. I also owe many thanks to my partner Hasfazilah Mokhta for helping and encouraged me to complete this thesis.

Last but not least, it is my pleasure to thank all others who have contributed either directly or indirectly give their support and guidance in completing this thesis.

Thank you.

The effect of chemical fertilizer on growth performances of *Arachis hypogaea* under two light intensity on BRIS soil.

ABSTRACT

In this study, Beach Ridges Interspersed with Swales (BRIS) soil which was a high sandy texture had been used to measure the germination of groundnut. They were poor both in physical and chemical properties likes low fertility, lack of nutrients, high permeability, high soluble salts and poor water holding. The objective of this study was to determine the effects of chemical fertilizer and the most suitable light intensity for groundnut production on the BRIS soil. This experiment was laid out in a Split-plot design with two treatments which consisted of BRIS soil and BRIS soil with chemical fertilizer and was placed under two different light intensity. Growth and yield parameters such as height, diameter, number of branches and leaflets and biomass production were assessed. To grow crops successfully, these soils must be improved. These results shown that addition of NPK fertilizer to BRIS soil improved BRIS soil health and increased groundnut production. Adding NPK fertilizer to BRIS soil significantly increased the nutrient to the soil and production of the groundnut

Kesan baja kimia ke atas pertumbuhan *Arachis hypogaea* di bawah dua keamatan cahaya yang berbeza di atas tanah BRIS.

ABSTRAK

Dalam kajian ini, tanah BRIS yang mempunyai tekstur berpasir yang tinggi telah digunakan untuk mengukur percambahan kacang tanah. Tanah ini miskin dari ciri fizikal dan kimia seperti kesuburan yang rendah, kekurangan nutrien, kebolehtelapan yang tinggi, garam larut yang tinggi dan pegangan air yang kurang baik. Objektif kajian ini adalah untuk menentukan kesan baja kimia dan keamatan cahaya yang paling sesuai untuk pengeluaran kacang tanah di tanah BRIS itu. Eksperimen ini telah diletakkan di dalam reka bentuk Split-plot yang terdiri daripada tanah BRIS sahaja dan tanah BRIS dengan baja kimia dan telah diletakkan di bawah dua keamatan cahaya yang berbeza. Pertumbuhan dan hasil parameter seperti ketinggian, diameter, bilangan dahan dan bilangan daun dan penghasilan biojisim telah dinilai. Bagi mendapatkan hasil tanaman yang baik, tanah ini perlu ditambahbaik. Keputusan kajian ini menunjukkan bahawa penambahan baja NPK kepada tanah BRIS meningkatkan kesihatan tanah BRIS dan meningkatkan pengeluaran kacang tanah. Peningkatan yang ketara terhadap nutrien tanah dan pengeluaran kacang tanah dapat dilihat dalam kajian ini apabila baja NPK ditambah ke atas tanah BRIS.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF ABBREVIATION

BRIS	Beach Ridges Interspersed with Swales
GP	Germination Percentage
N	Nitrogen
P	Phosphorus
K	Potassium
cm	centimetre
m	metre
km	kilometre
g	gram
ha	hectare

LIST OF SYMBOL

%	percentage
°C	degree Celcius

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Soil and fertilizer have strong relationships in agriculture field. The growth performance of plants depends to a certain extent on the proper management of soil and chemical fertilizer application. Soil is the mixture of gases, water, minerals, organic matter, and many others organisms that together support life on Earth. There are many types of soil exist on the Earth surface, one of them is sandy soil. In Peninsular Malaysia, BRIS (Beach Ridges Interspersed with Swales) soils are a type of sandy soil found along the coastal area in Terengganu (67,582.61 ha), in Pahang (36,017.17 ha), and in Kelantan (17,806.20 ha) (Armanto *et al.*, 2013). BRIS soils are often considered as soils with low fertility, poor water holding capacity and high soluble salts. Due to this low fertility problem, the productivity of soil can be improved by adding chemical fertilizer on soils.

Chemical fertilizer improves soil fertility by providing nutrients through mineralization and chemical fertilizers that are normally used are NPK fertilizer. This fertilizer is to improve soil fertility and to increase agricultural crop yields. Plants must obtain enough nutrients that are important for their growth (Shakhashiri,2012).The chemical fertilizers that are commonly used in the agriculture field are NPK fertilizer. These chemical fertilizers are used in this research to supply nutrient to the BRIS soil because this sandy soil are poor in physical and chemical properties.

This sandy soil can effect plant growth and give a low production in yields due to low fertility, poor water holding, high permeability and high soluble salts (Panchaban, 2007). Besides fertilizer, light intensity also has important roles for plant growth. Plants obtain their food via sun or solar energy. According to (Roberts, 2006) light environment is one of the significant abiotic factors that varies among habitats and is predicted to influence multiple trophic levels.

In agricultural ecosystem, the quality of plant can be produced when there is good fertility of soil. Soil brings a major impact in producing a healthy plants and chemical fertilizer as an improver to the soil. In this study, the *Arachis hypogae* will be planted on the BRIS soil because groundnuts usually grow well in light sandy to sandy-loam, well-drained and aerated soil (Waele, 2001). Therefore, the objective of this research is to determine the effect of chemical fertilizer on performances growth of groundnut and to study the most suitable light intensity for germination and growth of groundnut. Better growth performances of groundnut will be obtained when using chemical fertilizer under two light intensities. This study is to help the farmers outside there to use another media to growth plants likes BRIS soil besides using the ideal soil type which is loamy soil.

1.2 Problem Statement

Soil plays an important role to grow plants. BRIS soil which is a problematic soil will be used to check the growth performances of groundnut. BRIS soil has a high sandy texture which is low fertility, lack of nutrients, high permeability, high soluble salts and poor water holding. So, in order to improve the fertility of BRIS soil, chemical fertilizer must be added into the soil. Chemical fertilizer improves soil fertility by providing nutrients through mineralization to the soil and at the meantime, the chemical fertilizer will enhance the growth of groundnut. Groundnut usually grows well in light sandy to sandy-loam, well-drained and aerated soil, so it is a suitable plant to plant on the BRIS soil. Besides adding the fertilizer on BRIS soil, direct sunlight is affecting the growth performances of groundnut too. To overcome this problem, shading with black nets will be applied to the yield. This shading will be decrease the full sunlight and the shading that will be applied is 30% and 50%.

1.3 Objectives

The aims of this study are:

- To determine the effect of chemical fertilizer on growth performances of groundnut.
- To study the most suitable light intensity for germination and growth of groundnut.

CHAPTER 2

LITERATURE REVIEW

2.1 *Arachis hypogaea*

2.1.1 Origin and distribution

Arachis hypogaea is the botanical name for groundnut. The term *Arachis* is from the Greek word *Arachos,* which is mean a weed while *hypogaea* means underground chamber. Groundnut or peanut are the most common names that are used for this crop. The term of groundnut usually used in most countries of Asia, Africa, Europe and Australia, while in North and South America it always referred as peanut (Prasad, 2010). Groundnut refers to the pods with seeds that matured underground of soil and it is one of the world's most popular oil seed crops which are grown as an annual plant in warm climate area. *A. hypogaea* is a cultivated annually in South American, domesticated in the broad area between Brazil, Argentina, Paraguay, Peru and Bolivia (Tweneboah, 2000). He also reported that out of six million tonnes of groundnuts produced in Africa about 80% comes from the savannah zone to the south of the Sahara and only 5% from the analogous zone in the Southern Hemisphere. He also stated Nigeria, Senegal, Niger and the Sudan as the four largest producers in this zone. India is by far the largest world producer. Others include China, United State of America, The Gambia, Mali and Malaysia.

2.1.2 Taxonomy and classification

The genus *Arachis* belongs to family *Fabaceae*, subfamily *Papilionanceae*, tribe *Aeschynomeneae*, subtribe *Stylosanthinae*. This genus is morphologically well defined and distinguished from other genera by having a peg and geocarpic reproductive growth. The genus *Arachis* has more than 70 wild species of which only *Arachis hypogaea* is domesticated and commonly cultivated (Prasad, 2010).

According to Prasad, (2010) the taxonomy of the genus *Arachis* has been well documented and include 37 named species and a number of undescribed species. The genus had been divided into nine section likes *Arachis*, *Caulorrhizae*, *Erectoides*, *Extranervosae*, *Heteranthae*, *Procumbentes*, *Rhizomatosae*, *Trierectoides* and *Triseminalae*. Most of the earlier classifications of *Arachis hypogaea* were based on growth habit, presence or absence of seed dormancy and relative time of maturity. These cultivated groundnuts are divided into two large varieties which are Virginia and Spanish-Valencia.

2.1.3 Quality and size of seed

Groundnut seed is extremely will be affected to any physical damage and because of that, the seed should be handled with care at all times (Tarawali, 2014). Seed which is already damaged or split will not germinate or grow. It is really important to plant high quality seed likes seed in Figure 2.1, because better seed will produce healthier plants whereas poor quality seed will produce low quality plants and that seed should not be kept for planting (Nweke *et al.*, 2013).

Besides providing a quality of seed, Martinson (2009) stated that size of the seed brings several effects on the future performance of seedling. Uses of larger seeds tend to produce larger seedlings. A large and heavy seed has a greater nutritive reserve and usually produces strong seedlings with satisfactory development. The large-seeded species tend to survive longer in the absence of enough soil nutrients.

Figure 2.1: The quality of *Arachis hypogaea*.
(Source: https://www.plantvillage.org/en/topics/peanut-groundnut)

2.1.4 Uses of *Arachis hypogaea.*

In many countries groundnuts are consumed as peanut butter or crushed and used as oil in cooking or simply consumed as a confectionary snack roasted, salted or in sweets (Cilliers, n.d.). In other parts of the world they are boiled, either in the shell or unshelled. (Okello *et al.*,2013) stated that for people in many developing countries, groundnuts are the principal source of digestible protein (25 - 34%), cooking oil (44 - 56%), and vitamins. Groundnut is also a significant source of cash income in developing countries that contributes significantly to livelihoods and food security.

2.1.5 Diseases and pests

Plant protection has assumed greater importance in increasing agricultural production. In groundnut, late leaf spot and rust diseases as shown in Figure 2.2 are the most widely distributed and economically important foliar diseases causing severe damage to the crop (Subramanyam, 2012). Another common diseases that groundnut faced are bacterial diseases, fungal diseases, nematodes, parasitic, phytoplasma, virus and viruslike diseases (Kumar *et al*., 2014).

Figure 2.2: *Arachis hypogaea* rust diseases (Okello, 2013).

2.2 BRIS soil

2.2.1 Location and distribution

Malaysia has a vast area of BRIS soil with this type of soil covers about 155 400 hectares in Peninsular Malaysia and in Sabah, it is about 40 000 hectares (Roslan & Shamsuddin, 2011). BRIS soil is the major type of soil that can be found along the east coast of Peninsular Malaysia from Kelantan, Terengganu, Pahang and right down along the coast to the west coast of Johor. BRIS soil originates from sediment or sand from the sea that accumulated from the erosion of layers of steep cliffs by the sea during the monsoon season and has a coarse sand component. These soils usually found along the coastal area where the distances are between 0.2-0.8 km from the sea beach.

2.2.2 Types of BRIS soil

Based on drainage classes and absence or in absence of spodic horizon depths, BRIS soils can be divided into four soil series, such as Baging, Rhu Tapai, Rudua and Jambu as shown in Figure 2.3 (Usman, 2014).

Baging is located nearest and running parallel to the shoreline (first terrace) and the youngest among the three other soil series. The topography of this area was almost flat. Baging series do not show horizon differentiation and are classified as Entisols. These soils are commonly coarse textured where the water removed from the soil rapidly.

Rhu Tapai Series is commonly located on the second terraces in the distance away, which is more than 500 m from the first terraces. Rhu Tapai series are moderately well drained where the water is removed from the soil is slow compared to Baging series.

Rudua series are excessively drained. Water is removed very rapidly. The soils are commonly coarse-textured and have very high hydraulic conductivity. The Rudua series are more leached comparing to Rhu Tapai. Both soils are classified as Spodosols. Jambu Series are sited on the oldest among the terraces and located farthest away from the coastline. The Jambu series are classified also as Spodosols.

2.2.3 Characteristics

BRIS (Beach Ridges Interspersed with Swales) soil is a problematic soil due to some special physical and chemical characteristics that are not suitable for crop production except for certain crops (Jahan *et al.*, 2014).

BRIS soil has several characteristics which is very well drained, cannot hold water, less fertile than other soil. Plants with shallow roots are prone to die out as sandy soils lose moisture faster than other soil. Most of the nutrients in sandy soils are washed out quickly. BRIS soil is one of problematic soils because nutrients are not available in many aspects. BRIS soil has a high percentage of sand and this will slow down the growth of the plant.

There are several types of soil amendment that can be mixed with BRIS soil such as organic matter, organic fertilizer, chemical fertilizer and compost that can increase the soil health, water holding capacity and nutrient status. Only few crops that are found suitable to be planted on BRIS soil such as coconut and sweet potato. BRIS soil is a sandy soil and to increase the yield of groundnut, it is depends on proper selection of soil management and other management practices (Kabir *et al*., 2013). Figure 2.3 shows groundnut can grow well on the light sandy soil. Groundnut will be used to indicate whether they are suitable or not on the BRIS soil.

Figure 2.3: *Arachis hypogaea* seedlings in light sandy soil.
(Source: https://www.plantvillage.org/en/topics/peanut-groundnut)

2.3 NPK fertilizer

Plants may not grow well because of the lack of sufficient nutrients in the soil. Plants require six basic nutrients from the soil in order to grow healthy. These nutrients are nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), and magnesium (Mg). Typical nutrients in fertilizers are NPK.

Fertilizer is any material of natural or synthetic origin that is applied to soils or plant to supply nutrient for the growth of plants. Fertilizers will enhance the growth of plants. In this study, NPK fertilizer will be used and there are three main macronutrients in the fertilizers which are Nitrogen, Phosphorus and Potassium.

Nitrogen (N) is used by plants for producing leaf growth and greener leaves and it is very important to plant in larger amounts compared than the other elements. Urea and ammonia are both used as sources of nitrogen.

Phosphorus (P) is the second major essential nutrient that has to supply into the soil. Phosphorus (P) is essential to the plant root system where it plays an important role in nodulation of legume crops to produce a good quality yield (Basu, 2008). The last one is Potassium (K), this nutrient is for making strong stem growth, movement of water in plants and promotion of flowering and fruiting.

2.4 Light intensity

Light intensity can affect plant form, flowering, leaf size, and colour in both herbaceous and woody species (Stoepler & Lill, 2013). Plants develop acclimation and plasticity to cope with the varying light regimes (Zhang *et al.*, 2003). Among the main environmental factors, solar radiation is the most significant one that regulates the photosynthesis, and consequently, the plant survival, growth and adaptation. The majority of plant species have the ability to develop anatomical, morphological, biochemical alterations and physiological in response to different light intensities (Carvalho *et al.*, 2005).

2.4.1 Shading

The definition of shade is to prevent direct light from reaching something or another meaning is an area that is dark and cool under or behind something. In this research, black net will be used to shade the groundnut seed from getting full sunlight.

Shading nets are used to cover agricultural structures for protecting plants from high solar radiation in hot and sunny day (Al-Helal & Abdel-Ghany, 2010). Shade netting is used to lessen the effects of light from penetrate directly to the plants. The shade net has shading capabilities ranging between 8% and 95%, making it possible to adapt the system to crop requirements.

2.4.2 Effect of shading

Shading is very important to the plants where direct sunlight gives more energy to plants. For this study, there are two different shading that used which are 30% and 50%. Shading and photosynthesis are related each other because shading definitely affects the morphological and physical performance of developing plants (Chaudhry, 2001). The shading can be barriers for plants doing their photosynthesis which is photosynthesis is the process of green plants convert carbon dioxide and water into food using energy that are obtained from sunlight (Ching, 2013). The more sunlight a plant receives the better capacity it has to produce food through photosynthesis (Hlatshwayo, 2010).

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

The materials used in this project were seed of groundnuts, BRIS soil, chemical fertilizer (NPK), paranet, hoe, light meter, measuring tape, calliper, ruler, pencil and notebook.

3.2 Methods

3.2.1 Media preparation

Seeds of groundnut were obtained from agriculture suppliers. Pure seeds that were free from damage and pests were used for the experiment and then the seed were soaked into distilled water for 24 hours. BRIS soil from UMK Bachok was used throughout this experiment. The NPK fertilizers supplied by the Agropark store and the paranet bought from nursery store at Jeli.

3.2.2 Site preparation.

The experiments were carried out at the Agropark of Universiti Malaysia Kelantan Kampus Jeli (UMKKJ). The plot size was covered by the plastic mulch film before planted the groundnut as shown in Figure 3.1. This plastic mulch film which one of the side contained silver components and the other side original black in colour was used to avoid weed growth around the groundnut plants. .

Figure 3.1: Plastic mulch film that was applied before plant the groundnut seeds.

3.2.3 Experimental design

Black polybags (18cm x 30cm) were filled with two different media which were BRIS soil only and BRIS soil added chemical fertilizer. Each polybag were filled with 1.5kg BRIS soil and 0.5g of chemical fertilizer was added to 10 polybags every two weeks. 25g of NPK fertilizer was used for 10 weeks throughout this experiment. These two treatments replicated five times and each treatment will be consisted of 10 seed of groundnuts planted in black polybags. Then, these polybags will be placed under two light intensities which were 30% and 50%. Henceforth, watering was carried out twice a day, in the morning and late evening. Weeding, fungicides and insecticides applications were made when necessary.

The main plot for this research is light intensity, BRIS soil and BRIS soil add chemical fertilizer was sub-plot. The factors involved were shown in Table 1. A 2x2 factorial experiment was arranged in a split-plot design.

Table 3.1: Type of treatments that were used in the research.

Type of soil / **Light Intensity**	**BRIS Soil**	**BRIS soil with chemical fertilizer**
30%	5 seeds of groundnut	5 seeds of groundnut
50%	5 seeds of groundnut	5 seeds of groundnut

3.2.4 Light intensity measurement

In this study, the plot size was covered with the paranet under two different light intensities which were 30% and 50%. Light intensities were measured with a handheld light meter at the midday and the light sensor was held one meter (m) above soil level in each plot. Light meter was used to indicate the light before setting up the black net. Metal pole was used to hold the paranet, the example of shading net for plants was shown in Figure 3.2.

Figure 3.2: Shading net

3.2.5 Growth parameters and yield measurement

Observations were made every day for 10 days and all the seeds that were germinated were counted and percentage of germination was calculated. The number of seedlings which could not survive within 10 days after seed pre-treatment were counted and then expressed in percentage.

$$\%GP = \frac{seed\ germinated}{total\ seed} \times 100\%, \text{ where;} \qquad \text{Eq. 1}$$

GP = germination percentage.

Measurement of height was taken with a ruler. Height was taken from the surface of soil to the topmost point and a digital calliper and ruler was used to measure the diameter of the plant. Leaf number was counted when the leaf was visible. Then, the number of branches that comes out from the *Arachis hypogaea* was counted and the average for each plot was calculated. The observation on the four parameters was made every week.

Grown seedlings were dried after 10 weeks carrying out the experiment. The harvested plants were washed in running tap water to remove soil and soaked with blotting paper to remove the adhering water on it. Then the plants were separated into shoots and roots. The components were oven dried at 65°C for 48 hours to record constant dry weights (Rezaul, 2013). Then total dry weight was determined by recording the dry weight of each portion of the plant.

3.2.6 Statistical analysis

This experiment will be laid out in a Split-plot design with five replications. All the collected data were subjected to Analysis of variance (ANOVA) using Minitab Version 17 (Minitab Inc., Pensylvania, USA). Results were considered significance at 5% probability level.

3.2.7 Research flow chart

This was the flow chart for conducting this research.

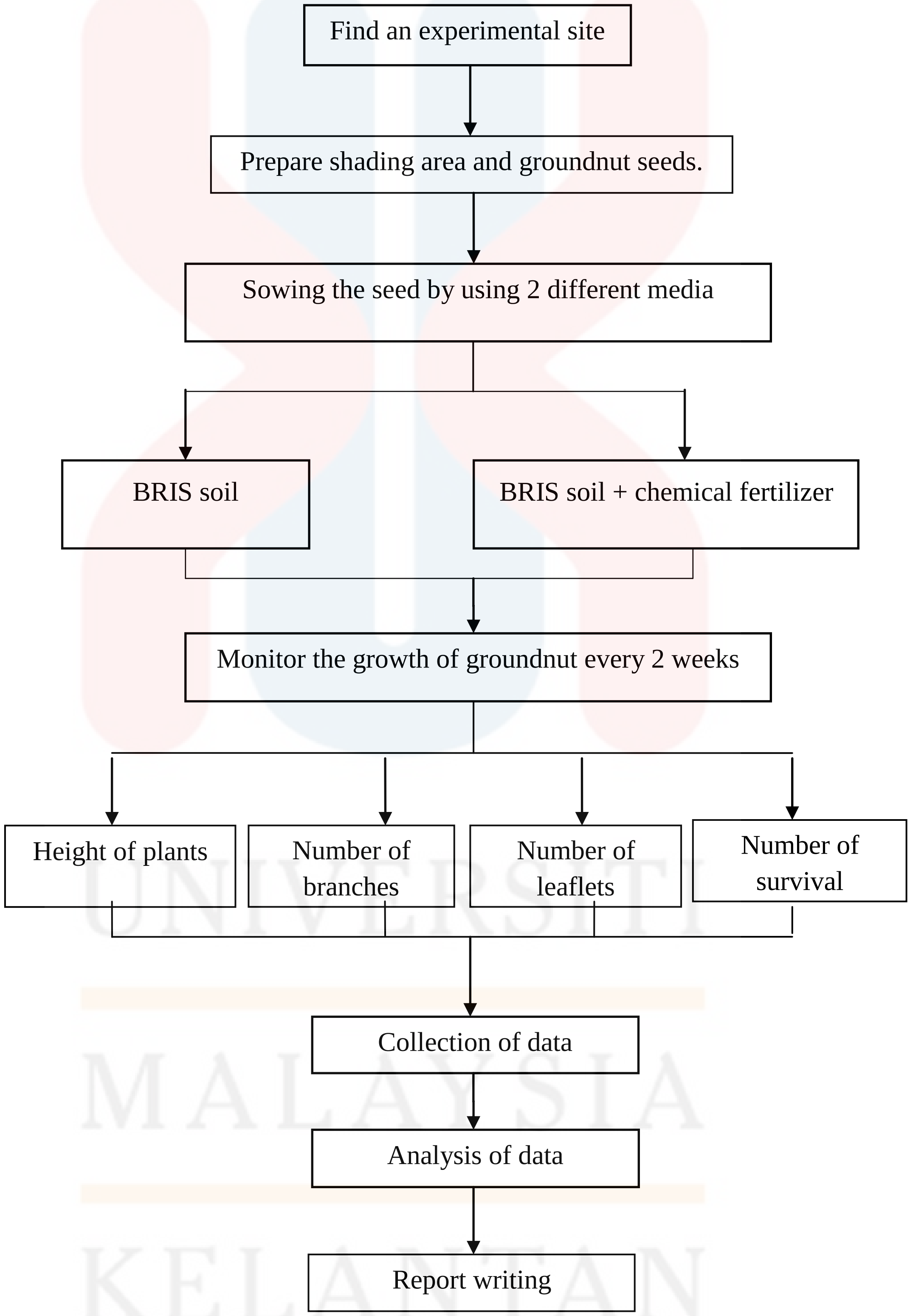

Figure 3.3: Flow chart for methodology.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Soil texture

The texture of soils is one of the important roles in planting the groundnut plants. It is determined by the size and type of particles that make up the soil (Brady,2008). In this experiment, the texture of BRIS soil was tested and the result showed that this soil has 92.4% sand, 4.8% silt and 2.8% clay. From the result, BRIS soil can be categorized as a sandy soil as shown in Figure 4.1.

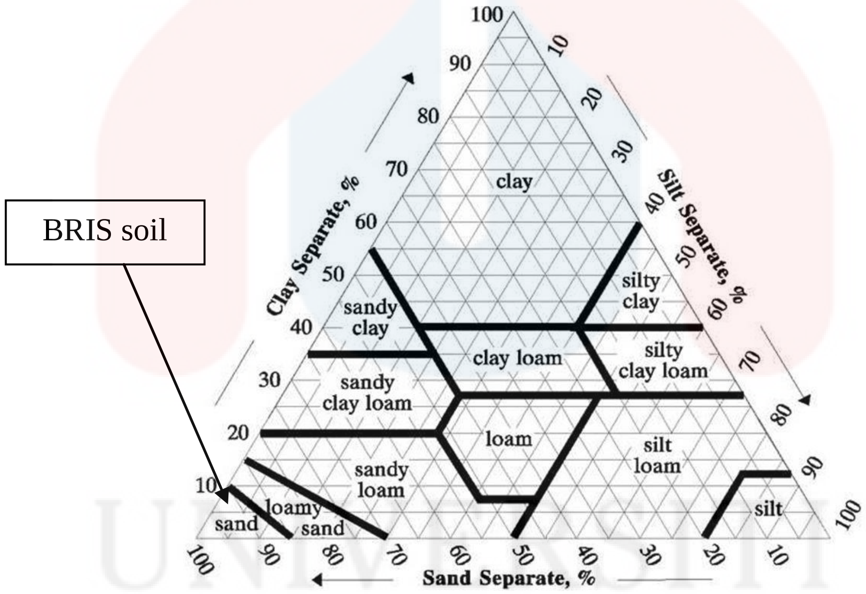

Figure 4.1: Physical properties of soil.

4.2 Percentage of seed germination

In this research, the seed of *Arachis hypogaea* was soaked in the distilled water within 24 hours for seed pre-treatment. The germinated seeds were counted after 10 days to calculate the germination percentage (GP), only 38 out of 50 was germinated and the result shown that the germination of seeds was 76%. Since the germination of seed was above 70%, it showed that the seed used in this research was a quality seed.

4.3 Growth performance of *Arachis hypogaea.*

4.3.1 Height of *Arachis hypogaea.*

The results presented here support the hypothesis that chemical fertilizer gives effect on the height performances of groundnut plants. Figure 4.2 present the height of groundnut under 30% light intensity and Figure 4.3 height of groundnut under 50% light intensity. From the graphs, it is shown that the height of groundnut plants increase rapidly when adding the NPK fertilizer on the BRIS soil. The productivity of groundnut depends on proper selection of variety, fertilizer management and other management practices (Lourduraj, 1999). Proper fertilizer doses of nitrogen, phosphorus, calcium and boron have vital effect on the yield of groundnut (Subrahmaniyam, 2000).

For both graphs (Figure 4.2 and 4.3), height of plants increased rapidly from the fourth week until the week tenth for plant treated with chemical fertilizer as compared to plants without chemical fertilizer. Height of plants in BRIS soil without chemical fertilizer increase slowly from first week until the last week (week 10^{th}) for both light intensities. The height of plants in BRIS soil only showed poor performances because they lacks of nutrients in the soil. According to Solaiman, (1991) nutrients from soil is one of the factors that contribute to the growth performances of plants.

Among the main environmental factors, solar radiation is the most significant one that regulates the photosynthesis, and consequently, the plant survival, growth and adaptation (George, 2012). From the results, 50% light intensity shown the higher growth performances of *Arachis hypogaea* compared to the 30% light intensity.

The results showed the graph of height of groundnut plants from the first week until to the tenth week.

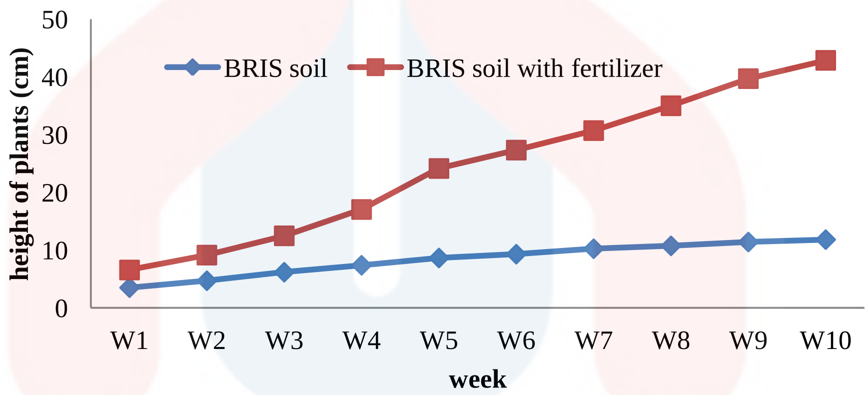

Figure 4.2: Height of plants under 30% light intensity

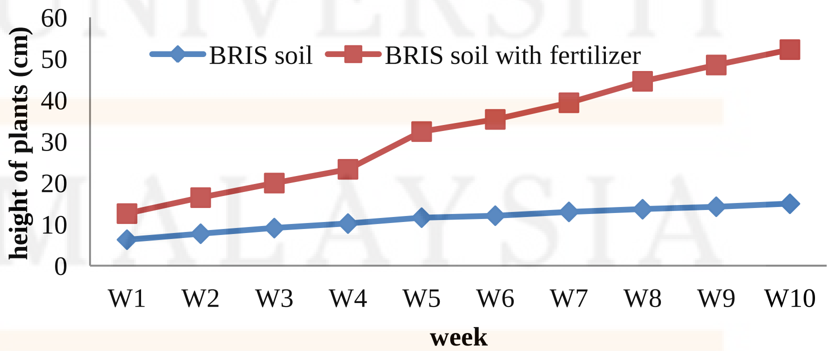

Figure 4.3: Height of plants under 50% light intensity

From the Analysis of variance (ANOVA), the plant height in first week (Table 4.1) showed that only light have a significant effect (p = 0.003). Media was not significant at first week because the root system was not fully developed. While at the fifth week (Table 4.2), there was a significant difference at media and light (Media: p = 0.000 and Light: p = 0.005) and similarly at week 10^{th} (Table 4.3), light and media had a significant effect (Media: p = 0.000 and Light: p = 0.028). The media had showed the significant effect at week 5^{th} and 10^{th} because the root system has started to develop and nutrients from media can be absorbed through the roots to the plants. Light was significant to the height of plants at all three weeks because light supply energy to the plants, so that plants got the energy from sun to grow. All the three weeks shown that no significant effect on height of plants on the interaction between media and light. It showed that effect on light not affected by the media. They were not interacting each other.

Table 4.1: Analysis of variance (ANOVA) for height at week 1^{st}.

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	***F*-Value**	***p*-Value**
Media	1	0.264	0.2645	0.07	0.792 n.s
Light	1	45.300	45.3005	12.27	0.003*
Media x Light	1	0.264	0.2645	0.07	0.792n.s
Error	16	59.080	3.6925		
Total	19	104.909			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.2: Analysis of variance (ANOVA) for height at week 5th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	316.013	316.013	39.19	0.000**
Light	1	87.780	87.780	10.89	0.005*
Media x Light	1	6.160	6.160	0.76	0.395n.s
Error	16	126.024	8.064		
Total	19	538.978			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.3: Analysis of variance (ANOVA) for height at week 10th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	2148.66	2148.66	114.94	0.000**
Light	1	109.04	109.04	5.83	0.028*
Media x Light	1	11.70	11.70	0.63	0.440n.s
Error	16	299.10	18.69		
Total	19	2568.52			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

4.3.2 Diameters of *Arachis hypogaea.*

At the first and second week collecting data, the diameter of groundnut plants cannot be measured yet due to small stem of plants like shown in Figure 4.4 and 4.5. In Figure 4.4, the diameter of stems that applied chemical fertilizer was higher compared to the diameter of stems that were not using chemical fertilizer. Only at week 5th, the two treatments show a small difference in diameter of stem of *Arachis hypogaea.*

Figure 4.5 shown the diameter of stems in BRIS soil and BRIS soil with fertilizer increased simultaneously from week 3rd to week 5th. Starting from week 6th, the diameter of stem in BRIS soil with the addition of chemical fertilizer was tremendously increased until it harvested. While the diameter of stems in BRIS soil shown slow increase rate from week 6th until week 10th. The growth rate of the diameter between two treatments showed the difference from it started until the end.

The result also showed that 50% of light intensity had the higher production compared to the 30% of light intensity. In this study, the paranet was used as shading to the plants from getting full sunlight. The shading can be barriers for plants doing their photosynthesis which is photosynthesis is the process of green plants convert carbon dioxide and water into food using energy that are obtained from sunlight (Ching, 2013). The more sunlight a plant receives the better capacity it has to produce food through photosynthesis (Hlatshwayo, 2010).

The results in Figure 4.4 and 4.5 show the diameter of groundnut plants from the first week to the tenth week for 30% and 50% light intensity respectively.

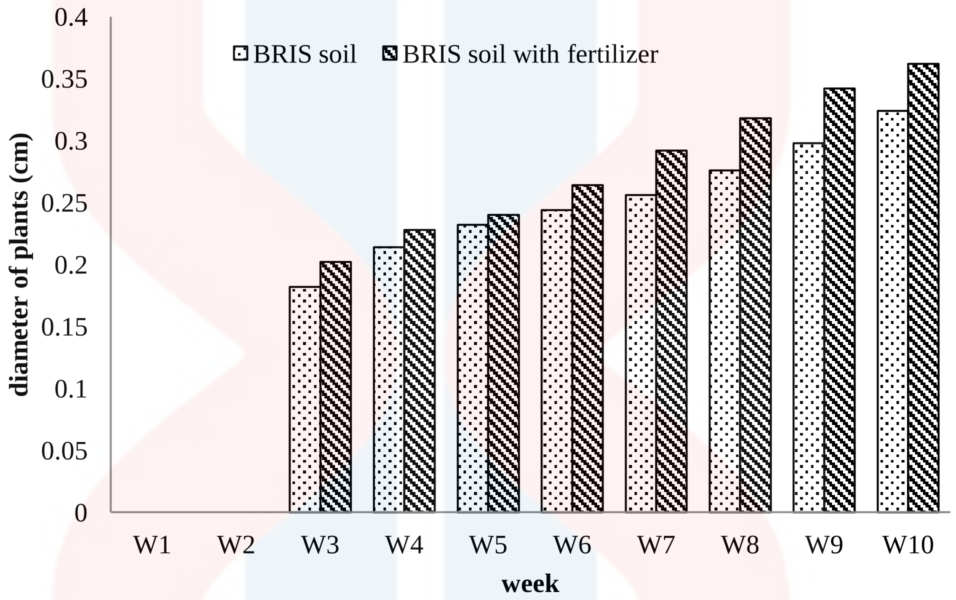

Figure 4.4:Diameter of stem under 30% light intensity

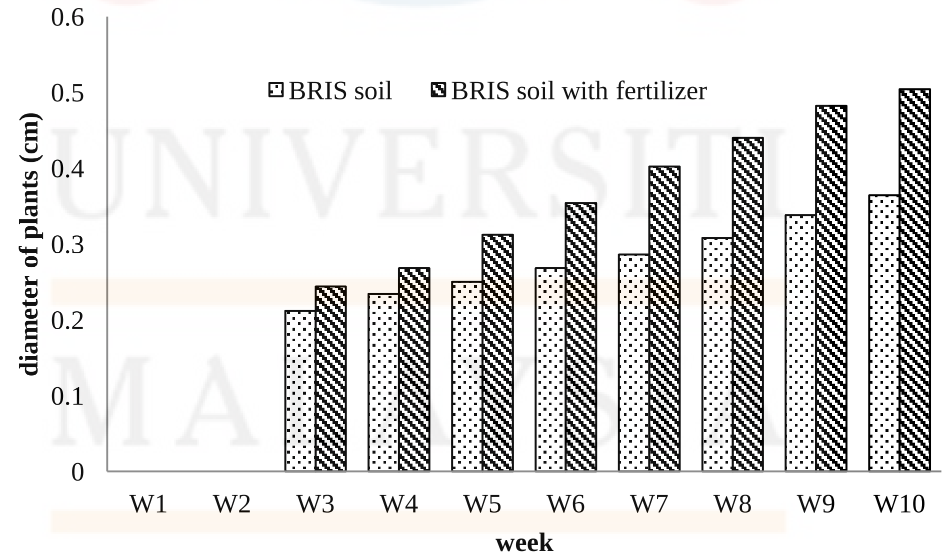

Figure 4.5: Diameter of stem under 50% light intensity

Results of the analysis of variance in (Table 4.4) clearly indicate that the diameter of *Arachis hypogaea* on the week 5th significantly affected by the media (*p*=0.008), light (*p*=0.019) and also between the interaction of the media and light (*p*=0.025). Thus, it indicates that the diameter of the plant in the week 5th was affected by the media, light and the interaction of the media and light. At week 10th (Table 4.5), only media (*p*=0.002) and light (*p*=0.002) showed the significant effect on the diameter of plants. Meanwhile the interaction between media and light had showed no significant effect (*p*=0.053) at < 0.05 significant level. Effect of light is not influenced by the effect of media on diameter growth probably because the fertilizer in the media not totally was being used by the plants.

Table 4.4: Analysis of variance (ANOVA) for diameter at week 5th.

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	***F*-Value**	***p*-Value**
Media	1	0.009245	0.009245	9.20	0.008*
Light	1	0.006845	0.006845	6.81	0.019*
Media x Light	1	0.006125	0.006125	6.09	0.025*
Error	16	0.016080	0.001005		
Total	19	0.038295			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.5: Analysis of variance (ANOVA) for diameter at week 10th.

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	***F*-Value**	***p*-Value**
Media	1	0.03961	0.039605	13.25	0.002*
Light	1	0.04140	0.041405	13.85	0.002*
Media x Light	1	0.01300	0.013005	4.35	0.053n.s
Error	16	0.04784	0.002990		
Total	19	0.14186			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

4.3.3 Number of branches.

Branching in groundnut plants may impact positively or negatively on yield since branches carry the leaves which were the major photosynthetic organs of the plant. Branching in groundnuts was genetic and depends on variety, but environmental factors can significantly impact on their development (Nweke, 2013).

In Figure 4.6, number of branches in two treatments increased slowly from week 1st until week 6th. Starting week 7th, the number of branches increased rapidly and sharply in BRIS soil with chemical fertilizer. Meanwhile, the other treatment showed slow growth rate until week 10th.

Figure 4.7 showed small difference number of branches between BRIS soil and BRIS soil with NPK fertilizer at week 1st until week 4th. The number of branches at week 5th and week 6th were constant at both treatments. A tremendous increase in branches number was found in BRIS soil with chemical fertilizer from week 7th to week 10th. The number of branches started to decrease at week 8th in BRIS soil and after that they were slowly increased until to week 10th.

The number of branches was measured for 10 weeks to see the effect of chemical fertilizer on the performances growth of groundnuts.

Figure 4.6: Number of branches under 30% light intensity

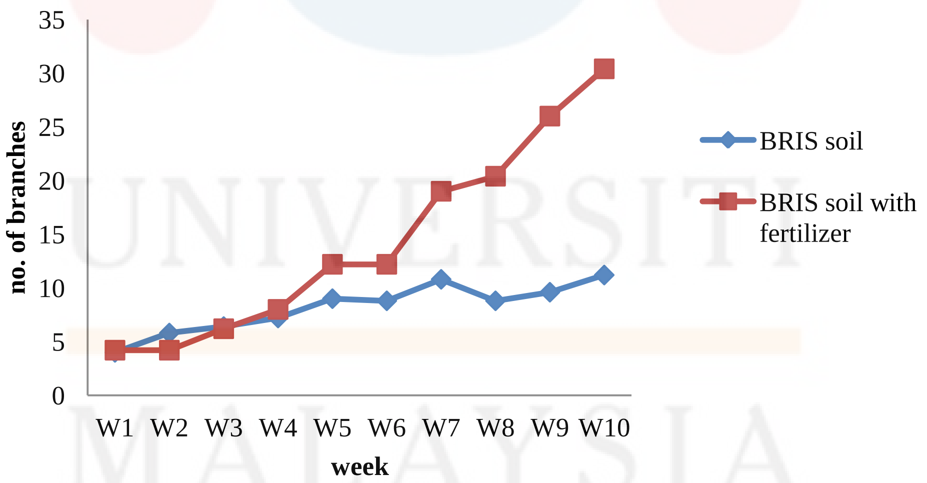

Figure 4.7: Number of branches under 50% light intensity

Based on ANOVA (Table 4.6), the treatments in week 1st had no significant effect on the number of branches (Media: *p* = 0.655, Light: *p*= 0.459 and Media x Light: *p* = 0.881). This might be happened because the root system was not developed very well at early stages. So, the nutrients cannot be absorbed by the root system of the plants and it affects the number of branches. The result at week 5th (Table 4.7) also shown that there was no significant effect on the number of branches (Media: *p*=0.286, Light: *p*= 0.560 and Media x Light: *p* = 0.126). However at the week 10th (Table 4.8), the media shown highly significant effect on the number of branches (*p*=0.000) and at this week light and interaction between Media x Light also seemed to have a significant effect on total number of branches (Light: *p*= 0.020 and Media x Light: *p* = 0.015). At week 10th, all the treatments were significant because root was already well developed to help in supplying the nutrients to the whole plants as such increase the number of branches.

Table 4.6: Analysis of variance (ANOVA) for number of branches at week 1st.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	0.4500	0.45000	0.21	0.655n.s
Light	1	1.2500	1.25000	0.57	0.459n.s
Media x Light	1	0.0500	0.05000	0.02	0.881n.s
Error	16	34.8000	2.17500		
Total	19	36.5500			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.7: Analysis of variance (ANOVA) for number of branches at week 5th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	8.450	8.450	1.22	0.286n.s
Light	1	2.450	2.450	0.35	0.560n.s
Media x Light	1	18.050	18.050	2.61	0.126n.s
Error	16	110.800	6.925		
Total	19	139.750			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.8: Analysis of variance (ANOVA) for number of branches at week 10th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	756.5	756.45	23.68	0.000**
Light	1	211.3	211.25	6.61	0.020*
Media x Light	1	238.0	238.05	7.45	0.015*
Error	16	511.2	31.95		
Total	19	1717.0			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

4.3.4 Number of leaves

Result of the number of leaves at all sampling days were presented in Figure 4.8. Number of leaves for the BRIS soil with fertilizer was greater at the week 1st compared to the number of leaves at the BRIS soil only. Then, starting from week 2nd to week 7th, the number of leaves in BRIS soil was higher than those from BRIS soil with the application of chemical fertilizer. Number of leaves in BRIS soil with chemical fertilizer was increase sharply from week 7th to week 8th and it is continuously increase until week 10th.

From the result in Figure 4.9, the two treatments show a small difference number of leaves from week 1st to week 4th. From week 6th until week 10th, the number of leaves in BRIS soil with fertilizer increased sharply due to the enough nutrient uptakes to the plants. Numbers of leaves decreased at week 8th in BRIS soil treatment. This might be happened because of diseases and pests. A week after that, the production of leaves was slowly increased until it harvested.

Light intensity also influenced branching and leaves significantly in the both treatments. The leaves under 50% light intensity got enough sun to do photosynthesis compared to the 30% of light intensity. Because of that, the number of branches and leaves under 50% light intensity was higher than 30% of light intensity. Crop productivity and quality are dependent on light interception and distribution in the canopy because infra- and inter-plant shading influences CO_2 net assimilation and transpiration due to different temperatures, humidity and light levels inside the canopy (Davide, 2003).

The number of leaves was measured from 1st week to week 10th.

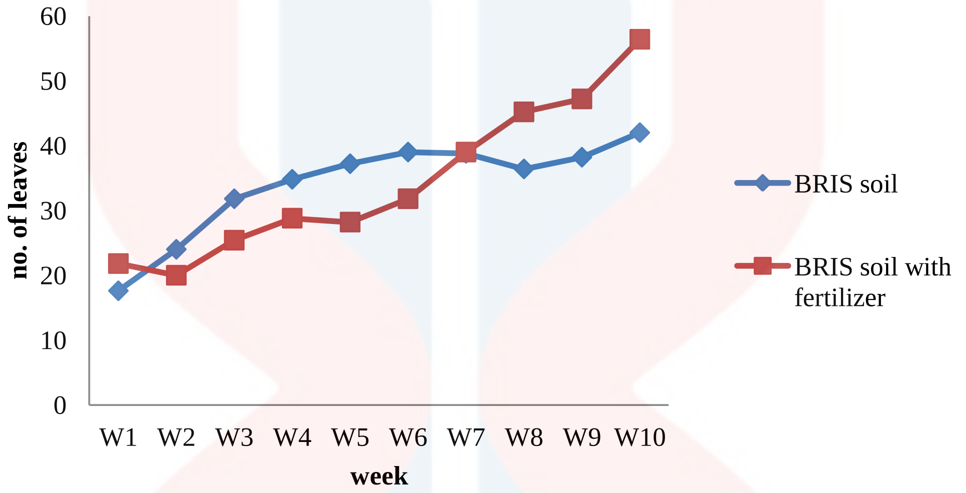

Figure 4.8: Number of leaves under 30% light intensity

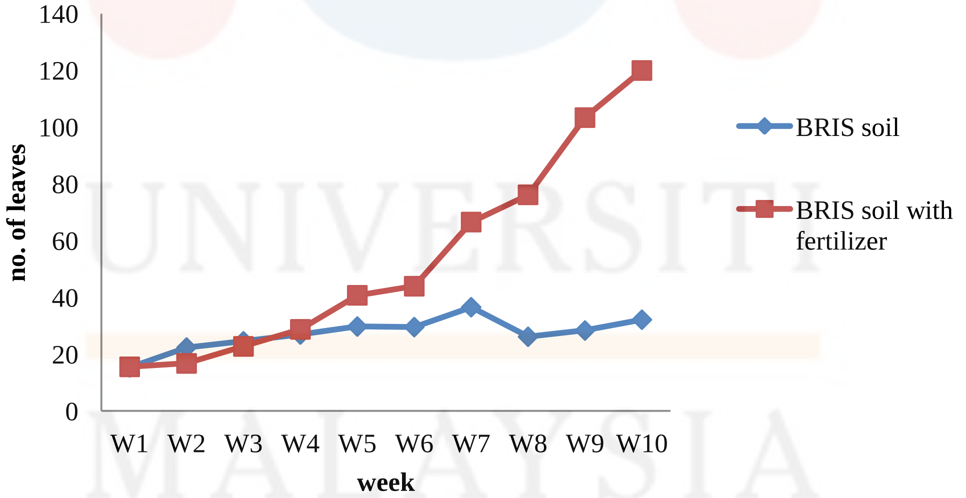

Figure 4.9: Number of leaves under 50% light intensity

Branch and leaf were related to each other. Based on the result in the ANOVA (Table 4.9) there was no significant effect on the number of leaves in week 1st (Media: *p* = 0.461, Light: *p*= 0.169 and Media x Light: *p* = 0.502). Since the branches at week 1st not fully developed, the leaves also not being produced. As we know, leaves were attached to the branches. The same goes to the result at week 5th (Table 4.10), where there was no significant effect on the number of leaves (Media: *p*= 0.883, Light: *p*= 0.702 and Media x Light: *p* = 0.154). Lastly at week 10th (Table 4.11), the media shown highly significant effect on the number of leaves (*p* = 0.000). The light and the interaction between Media x Light also seemed to have a significant effect on total number of leaves (Light: *p*= 0.023 and Media x Light: *p* = 0.003). At this week, all the treatments showed the significant effect on the number of leaves probably because they have enough nutrients to be absorbed by root and influence the number of leaves.

Table 4.9: Analysis of variance (ANOVA) for number of leaves at week 1st.

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	***F*-Value**	***p*-Value**
Media	1	24.20	24.20	0.57	0.461n.s
Light	1	88.20	88.20	2.08	0.169n.s
Media x Light	1	20.00	20.00	0.47	0.502n.s
Error	16	678.40	42.40		
Total	19	810.80			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.10: Analysis of variance (ANOVA) for number of leaves at week 5th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	5.00	5.000	0.02	0.883n.s
Light	1	33.80	33.800	0.15	0.702n.s
Media x Light	1	500.00	500.00	2.24	0.154n.s
Error	16	3569.20	223.075		
Total	19	4108.00			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

Table 4.11: Analysis of variance (ANOVA) for number of leaves at week 10th.

Source	Degree of Freedom	Sum Square	Mean Square	*F*-Value	*p*-Value
Media	1	13056	13056.1	23.00	0.000**
Light	1	3618	3618.0	6.37	0.023*
Media x Light	1	6734	6734.4	11.86	0.003*
Error	16	9082	567.6		
Total	19	32491			

*Note: * = significant difference (p<0.05), ** = highly significant difference (p<0.001), n.s = not significant (p>0.05)*

4.4 Biomass production

At the end of this experiment, fresh weight and dry weight of *Arachis hypogaea* were measured to determine the biomass production. Figure 4.10 shown the fresh weight in BRIS soil was 1.24, which were 3.7 lower than fresh weight in BRIS soil with addition of chemical fertilizer. The dry weight in BRIS soil was 0.49 and the dry weight of BRIS soil with chemical fertilizer was 1.43. NPK fertilizer application significantly increased dry weight of groundnuts plants. Similar results have been reported by (El- Habbasha *et al*., 2005 and Gobarah *et al.*, 2006).

Result of the total fresh and dried weight of groundnut in 50% light intensity was presented in figure 4.11. The graph shown the fresh weight of groundnut in BRIS soil was 1.76g and dried weight is 0.7g. Next, the fresh weight of BRIS soil with chemical fertilizer was 17.53 and the dry weight was 5.84. The moisture content loss by groundnut in BRIS soil without fertilizer was lower compared to the BRIS soil with fertilizer because environmental factors soil aeration, soil structure, soil reaction and supply of mineral nutrients.

Between 30% and 50% light intensity, biomass production under 50% light intensity was higher compared to the 30% light intensity. Intermediate light conditions (about 50% of light) were more adequate for some species to reach higher levels of biomass productivity (Carvalho *et al*., 2005). According to previous comparative studies, the biomass of roots, stems, leaves and whole plant as well as the photosynthetic rate, the transpiration and the stomata conductance of water vapour decreased under low light (Zhang *et al.*, 2003).

The result below (Figure 4.10 and 4.11) shows the total fresh and dried weight of groundnut in two different light intensity.

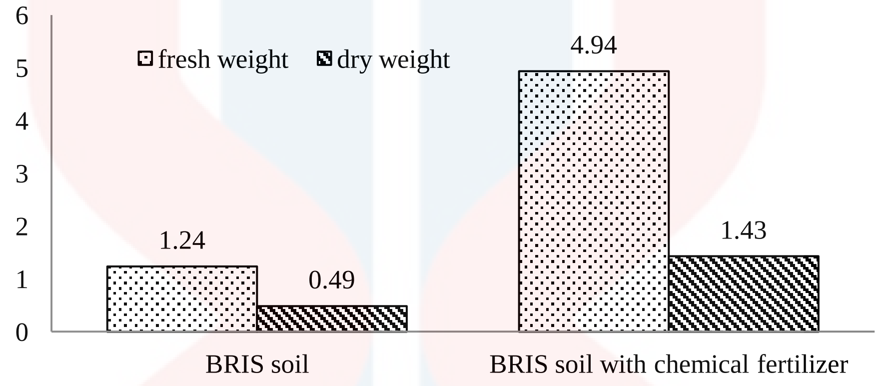

Figure 4.10: Total fresh and dried weight of groundnut in 30% light intensity.

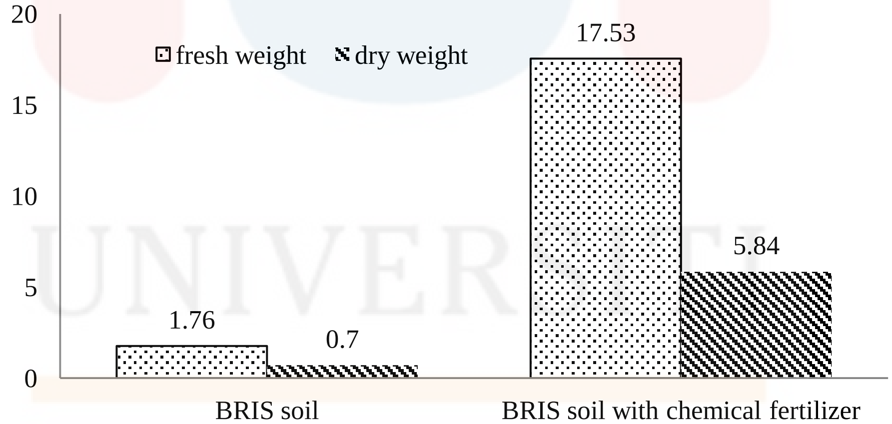

Figure 4.11: Total fresh and dried weight of groundnut in 50% light intensity.

4.5 Diseases and pest.

Groundnuts are exposed to pests and diseases that reduce yield and quality of plants. Groundnut rosette disease is a very serious viral disease of groundnuts widespread in sub-Saharan Africa and its off-shore islands (Waliyar *et al*., 2007). Groundnuts were often attacked by fungi, bacteria, viruses and pests. The most common fungal pathogens known to drastically reduce yield and/or quality of the crop include leaf spots and rusts (Prasad, 2010).This study however, show least impact of the diseases and pests to the growth performances of groundnut, these diseases and pest only affected the number of leaves. There were some of problems that were detected during this research.

Figure 4.12 shown that leaves of *Arachis hypogaea* were bitten by insects/pests. Insects/pests such as caterpillars, grasshoppers and others are voracious feeders and cause defoliation of the crop.

Figure 4.12: Leaves were bite by the insects/pests.

Figure 4.13 showed the Alternaria leaf spot (*Alternaria alternata*). Lesions are brown in colour, and irregular in shape surrounded by yellowish halos. Light to dark brown blighting of apical portion of leaflets are seen. The blighted leaves curl inward and become brittle (Thirumalaisamy *et al.*, 2011).

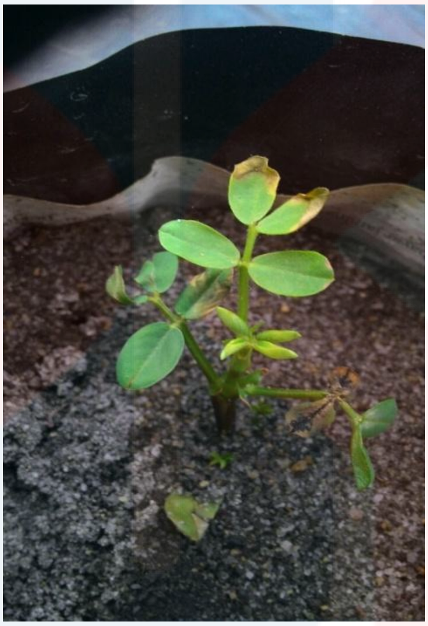

Figure 4.13: Alternaria leaf spot.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

As a conclusion, this research shows that the application of NPK fertilizer in combination of BRIS soil gives the best growth and yield of groundnut. In this research, the effect of chemical fertilizer on four parameters (height, diameter, number of branches and number of leaves) can be seen starting at week 8^{th} using 20 g of NPK fertilizer.

The results of this experiment also show that 50% light intensity gives more effects compared to 30% light intensity. The 50% light intensity was found to be ideal light for the growth of *Arachis hypogaea* because the more sunlight a plant receives the better capacity it has to produce food through photosynthesis (Hlatshwayo, 2010).

Throughout this study, what can be suggested is BRIS soil can be commercialised to the farmers in the coastal area. Although BRIS soil is lacking of nutrient but this problem can be solved through application of fertilizer. Besides that, BRIS soil also suitable for growing shade tolerance crop species. From the present research, it is shown that groundnut can be growing even under full sunlight.

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APPENDICES

Reproductive growth stages of peanut.

Figure A2: the groundnut seed.

Figure A3: peanut seed was germinated

Figure A4: the peanut flower start to bloom

Figure A5: pegs entering the soil

Figure A6: beginning pod.

Figure A7: full pod when harvested.