The Effect of Green Manure (Leaves of *Sesbania grandiflora* and *Gliricidia maculata*) on the Growth of Groundnut (*Arachis hypogaea*) Grown on BRIS Soil

by

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DECLARATION

I declare that this thesis entitled "The Effect of Green Manure (Leaves of *Sesbania grandiflora* and *Gliricidia maculata*) on the Growth of Groundnut (*Arachis hypogaea*) Grown 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 : NURRUL AZZEHA BINTI SULAIMAN

Date : 8 JANUARY 2017

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ABSTRACT

BRIS (Beach Ridges Interspersed with Swales) soil is a problematic soil in Malaysia. The present study focuses on how to improve BRIS soil as a sandy soil contain poor nutrients with low water holding capacity and organic matter. More than 90% of the composition of BRIS soil is sand and the soil is considered practically worthless for agricultural purposes. Application two types of green manure which is *Sesbania grandiflora* and *Gliricidia maculata* leaves in order to solve the problematic of BRIS soil. Twenty-four *Arachis hypogaea* plants were test growth performance on BRIS soil and conducted under full sunlight. The experiments were laid out in a Completely Randomized Design with four replications. Parameters that measured are plant height, total leaves number, diameter, dry biomass production and Relative Growth Rate (RGR). The result of ANOVA for height *Arachis hypogaea* where only week 4 and week 8 shows significant value on media which are week 4 (P=0.007) and week 8 (P=0.000). Total number of leaves showed week 8 has significant value which is P=0.024 on media. While, diameter *Arachis hypogaea* showed week 1 has significant value on media P=0.004. Then, RGR showed significant value on media P=0.002. The different media and type of green manure is main variables, it was shown that there was no significant relationship between media and green manure in the composition of the soil. No significant differences were recorded for green manure as treatment throughout 66 days experimental period. Only media that contained ratios gave effect on the growth performance of *Arachis hypogaea*.

Kesan Baja Hijau (Daun *Sesbania grandiflora* dan *Gliricidia maculata*) pada Pertumbuhan Kacang Tanah (*Arachis hypogaea*) yang Ditanam di atas Tanah BERIS

ABSTRAK

Tanah Beris merupakan salah satu tanah bermasalah di Malaysia. Kajian ini tertumpu kepada cara untuk meningkatkan tanah beris sebagai tanah berpasir yang mengandungi kekurangan nutrien, keupayaan memegang air yang rendah dan bahan organik. Lebih daripada 90% daripada komposisi tanah Beris adalah jenis pasir dan tanah jenis ini yang dianggap tidak sesuai bagi tujuan pertanian. Penggunaan kedua-dua jenis baja hijau (*Sesbania grandiflora* dan *Gliricidia maculata*) dalam usaha untuk menyelesaikan masalah tanah beris. Dua puluh empat biji benih *Arachis hypogaea* diuji pertumbuhannya pada tanah beris dan dijalankan di bawah cahaya matahari penuh. Kajian ini di susun dalam Reka Bentuk Sepenuhnya Rawak dengan empat replikasi. Parameter yang diukur adalah ketinggian pokok, jumlah daun, diameter batang pokok, biojisim dan Kadar Relatif Pertumbuhan. Keputusan daripada analisis ANOVA bagi ketinggian *Arachis hypogaea* di mana minggu 4 dan minggu 8 menunjukkan nilai signifikasi pada media minggu 4 (P=0.007) dan minggu 8 (P=0.000). Jumlah daun menunjukkan minggu 8 mempunyai nilai signifikasi P=0.024 pada media. Sementara, diameter *Arachis hypogaea* bagi minggu 1 menunjukkan nilai signifikasi pada media P=0.004. Kadar Relatif Pertumbuhan menunjukkan nilai signifikasi pada media P=0.002. Media yang berbeza dan jenis baja hijau adalah pembolehubah utama, ia menunjukkan bahawa tidak ada hubungan yang signifikan di antara media dan baja hijau di dalam komposisi tanah. Tiada perbezaan yang ketara dicatatkan bagi baja hijau sebagai rawatan sepanjang 66 hari tempoh kajian. Hanya media yang mengandungi nisbah memberi kesan ke atas prestasi pertumbuhan *Arachis hypogaea*.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF EQUATIONS

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BRIS	Beach Ridge Interspersed with Swales
CO_2	Carbon dioxide
cm	Centimeter
CRD	Completely Randomized Design
FC	Field Capacity
FAMA	Federal Agricultural and Marketing Authority
g	Gram
GLM	General Linear Model
kg	Kilogram
m	Meter
MC	Moisture Content
ml	Milliliter
mm	Millimeter
PWP	Permanent Wilting Point
RGR	Relative Growth Rate

LIST OF SYMBOLS

°C	Celsius
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Background of study

Groundnut or peanut belongs to the genus *Arachis* of family *Leguminosae*. This genus has about 70 wild species (Prasad et al., 2009). In fact, Greek words which is *Arachis* meaning legume and *hypogaea* is underground and the species name for groundnut is *Arachis hypogaea* Linn., referring to the formation of pods in the soil (Prasad et al., 2009). The type of soil suitable for *Arachis hypogaea* should be loose to facilitate the harvesting of the crop.

Arachis hypogaea needs full sunlight and warmth for normal development. The temperature affects the rate germination and plant development. Many stresses also influence the growth of *Arachis hypogaea* among of that are biotic stress, high temperature stress, drought stress and also nutrient stress (Prasad et al., 2009).

Arachis hypogaea requires rainfall of about 1250 mm and temperature of about 27-30°C for optimum growth and development (Okello et al., 2014). When *A.hypogaea* grow with the good environmental requirements, the production area and the productivity of crop is increasing and becoming a cash crop. Cash crop can give profits to the farmers and serves as a source of their sustenance. Furthermore, it provides revenue to the government.

Nevertheless, when the *Arachis hypogaea* crop is cultivated in the BRIS soil, the crop management is important. BRIS soil is generally known as problematic soil (Lah et al., 2011), because there are only a few crops that can survive in the soil. A low water holding capacity of this soil could be overcome by applying optimal drainage or irrigation management.

BRIS soils are not well utilized for crop production due to their inherent poor fertility (Roslan et al., 2011). Previous study by Lim in 1989 as cited by (Ishaq et al., 2013) mentioned that the distribution and properties of BRIS soil in Malay Peninsula have been taxonomically classified as either Spodosols or Entisols.

In this experiment, to *Sesbania grandiflora* and *Gliricidia maculata* were chosen as a green manure to treat BRIS soil because easily found in the study area, also want to know the effectiveness of *Sesbania grandiflora* as a shading on project in Bachok, Kelantan. Objective of this study to determine the effect different amount of BRIS soil on the growth of *A. hypogaea* and to compare the effectiveness of *Sesbania grandiflora* and *Gliricidia maculata* leaves as the green manure in BRIS soil.

1.2 Problem Statement

BRIS soil is a sandy soil of poor nutrients with low water holding capacity and organic matter. In order to utilize this problematic, soil improvement has to be made by using suitable watering schedule and application of green manure. *A.hypogaea* as a leguminous crop is expected to give better yield which has been improved on BRIS soil due to its hardiness and having a soil improving capacity, through biological nitrogen fixation. The yield of groundnut crop grown under BRIS improved will be increasingly high in number. Any crops can be cultivated on BRIS soil after improving its physical and chemical properties of BRIS soil.

1.3 Objectives

The two main objectives of this study are: -

1.3.1 To determine the effect of different amount of BRIS soil on the growth of *A. hypogaea*.

1.3.2 To compare the effectiveness of *Sesbania grandiflora* and *Gliricidia maculata* leaves as the green manure in BRIS soil.

CHAPTER 2

LITERATURE REVIEW

2.1 BRIS soil

BRIS (Beach Ridges Interspersed with Swale) soil is one type of poor soil that has many problems containing high percentage of sand particles about 82 to 99% than that of silt or clay (Nur et al., 2015). BRIS soil mostly can be found along the coastal area in Peninsular Malaysia in the states of Kelantan, Terengganu and Pahang cover about 155, 500 ha (Hossain et al., 2012). Hanafi et al. (2010), mentioned that BRIS soil do not perform well due to the high surface soil temperature, low water holding capacity, low organic matter content, high infiltration rate, low nutrients availability and not suitable for most of crops.

An addition of compost to BRIS soil will increase soil productivity (Lah et al., 2011). When mixing of top soil or compost with BRIS soil gives the less good result compared to the topsoil and compost mixing with BRIS (Jahan et al., 2014). A good crop environmental require suitable management practices in order to grow crop successfully.

According by Ishaq et al., (2013), decomposed manure will improve the BRIS soil productivity by controlling water holding capacity. BRIS soil can be developed into a potentially agriculture media using a good watering schedule and green manure. Thus, many challenges to manage BRIS soil for minimize leaching losses under the root zone.

2.2 Soil moisture

Effect of soil moisture content on soil temperature is complex. The soil characteristics for instance structure and texture have important effects on suitability of soil as a medium for plant growth. The changes of soil moisture affect both the energy and water cycles in the soil. According by (Foth, 1990; Perez, 1991), mentioned subtracting the amount of water held at the permanent welting point from the water stored at field capacity can measure directly the moisture availability in soil. The characteristic of the soil link with success of plants in which they grow because it is the source of the water and mineral nutrients essential for growth (Kramer & Boyer, 1995).

Moreover, the spaces between mineral and organic in soil is filled with air and water. If the space is filled with water without air, then the soil is called saturated. When the space is filled with water and air again it is described as being in field capacity as the soil particles only holds a certain quantity.

Entin et al., (1999) stated that the interaction between land of surface and atmosphere will be controlled by soil moisture. In the soil, evaporation from soil surfaces occurs when the concentration of water vapour close to the surface is higher than that in the atmosphere. Soil moisture content plays an important role in biophysical process such as seed germination, plant growth and plant nutrition (Bittelli, 2011).

The higher of soil moisture will reduced risk of yield losses due to drought. Some previous studies showed soil moisture conditions on soil carbon dioxide (CO_2) emission will give effect in global warming (Zhou et al., 2014). Thus, soil moisture is very important to ensure that the seeds always get mineral nutrient and grow well.

2.3 Green manure

One of the method to sustain soil fertility is using green manure. Green manure is a fertilizers consisting of plants to improve the soil (Rosenfeld & Rayns, 2011). Green manure crops are those which are grown for the purpose of improving structure and nutrient content in the soil. The use of green manures will assist in supplying these need. Some cash crops depend on specific green manures for better production (Vakeesan et al., 2008). Moreover, Miller and Turk (2008) reported yields of subsequent crops will be increased when using green manure crops. In dry season, green manures enhanced yields of crops, which could be attributed to improvement of soil water holding capacity (Sangakkara et al., 2008).

Furthermore, the uses of green manure will minimize the usage of chemical fertilizers that are costly and also environmentally unfriendly. As an example, Egodawatta et al., (2011) stated that by using *Gliricidia* as green manure and found a significant benefit on yields, irrespective of the tendency positions and fertilizer application. The green manure influence to improve soil biological, physical and chemical properties and increase field crops productivity (Veeramani et al., 2012). Green manure will assist in increasing soil, increases crop productivity and nutrient level. *Sesbania* and *Gliricidia* (Figure 2.1 and 2.2) are among of potential green leaf manuring crop that can be used in improving the soil fertility and soil structure. Thus, green manuring is a practice that assisted in increasing the organic carbon content of sandy soils.

Figure 2.1: *Sesbania grandiflora*

Sources:
http://www.gbpuatcbsh.ac.in/departments/bi/database/phyto_onco_therapeutic/details.php?id=326

Figure 2.2: *Gliricidia maculata*

Sources:
http://www.blackoliveeastnursery.net/index.php?main_page=product_info&products_id=21488

2.4 *Arachis hypogaea* (Groundnut)

Arachis hypogaea is one of the economic important crops in tropical region. Around 15th century, Asians received groundnuts from Africa and then the agroecosystem of groundnuts widespread into regions in Southeast Asia such as Indonesia, Vietnam, Thailand, Malaysia and Myanmar. Chinese travelers was introduced *A. hypogaea* to Indonesia and Malaysia. While, in India, *A. hypogaea* cultivated in several parts is an important as oilseed crop (Bala & Nath, 2015). *A. hypogaea* grow up in tropical and warm temperate regions of the world.

In agriculture, groundnut can be grown and produce as a crop in the soil not too hard or too wet at harvest time (Ramakrishna et al., 2008). While, Ntare et al. (2008) expressed that the residual fertility responds better than direct fertilization for *A. hypogaea*. Key role for favorable outcome production of *A. hypogaea* need the optimization of the mineral nutrition because it has very high nutrient requirement (Bala & Nath, 2015).

The population of *Azospirillum sp.* and the rate of ammonification significantly higher in a vertisol and a laterite soil from a groundnut plantation (Srinivasulu et al., 2012). On the yields and quality produce of *A. hypogaea* needed for profitable with production a uniform stand of healthy, vigorous plants is important (Okello et al., 2013).

2.5 Seed pre-treatment

The seed pre-treatment is optional in order to speed up the process of seed germination and produce quality crop. Seeds of many tree species germinated readily when subjected to favorable conditions of moisture and temperature. *A. hypogaea* seed must choose in dry condition, healthy, uniform size then presoaked in distilled water for 24 hours (Neelamegam & Sutha, 2015). While, Ramakrishna et al., (2008) reported, seeds can be soaked in water solution overnight before planting to give effects of softening the outer skin or seed coat. This pre-treatment purpose is easy to *A. hypogaea* seed germinate and also effective. Furthermore, the seed that been treated with chlorpyriphos at 6.5ml /kg of seed reduced termites damage attach (Okello et al., 2013).

2.6 Seed germination

The process in which seed of *A. hypogaea* developed into a new plant is called germination. The seeds need growth media, ample water, oxygen and suitable temperature in order to germinate successfully. *A. hypogaea* seed germinates best at soil temperatures of 20–30°C (Prasad et al., 2009). Having good quality seeds will improve the germination rate. The visible sign of germination is appearance of radicle and shoot. A number of complex cell activities and both genetic and environmental factors play a key role in modifying of seed germination and storage behavior (Mng'omba et al., 2007). Oxygen is used for respiration, optimum temperature is necessary for metabolism and growth of the plants, while water is needed during absorption of the plants (Hartmann et al., 2002).

The seed of groundnut will take about six to 14 days after planting to germinate (Ramakrishna et al., 2008). Ramakrishna et al., (2008) also stated that *A. hypogaea* seedlings can push through quite crusted soils. Seed of *A. hypogaea* will germinate in optimum temperatures of 27 - 30 °C (Okello et al., 2014).

Rainfall ensures germination of seed when soil moisture is enough to resume the growth and stand establishment (Okello et al., 2013). Seeds sown in inappropriate depth will cause difficulties for seed to sprout and grown. Seed will germinate in quality environmental requirement and given the best treatment.

2.7 Disease and pests

Arachis hypogaea seed should be treated to stop diseases that damage the seed and reducing seed germination and establishment. Disease and pests will decrease nutrient on the plant and also the soil. It will also affect groundnut productivity and the quality of produce such as poor pod filling, low shelling outturn, small seed size, shriveled seed, seed discolouration, seed damage, low germination and others (Okello et al., 2014). Insecticides require to control *A. hypogaea* from insect pests such as white grubs, jassids and aphids (Ramakrishna et al., 2008). *A. hypogaea* also has potential for particular viral diseases and pod diseases (Department of Agriculture, 2010). Larvae of a small moth as pest which burrows and mines into the leaves of the plant called *A.hypogaea* leaf miner and it symptoms leaf appearance a hole and rusty on leaves (N2Africa, 2014). Among two to three weeks after planting, the symptoms bacterial diseases which is bacterial wilt can occur (N2Africa, 2014).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study area

The study was conducted in a selected site within at the Agropark of Jeli Campus, Universiti Malaysia Kelantan (UMK), (Figure 3.1). Experiments conducted completely within 66 days.

Figure 3.1: Site at the Agropark of Jeli Campus

3.2 Materials

The seed of *A. hypogaea* was supplied by Universiti Malaysia Kelantan while the BRIS soil was taken from a site in Bachok, Kelantan (Figure 3.2). BRIS soil is brought to wood laboratory, where it is mixed and sieved (Figure 3.3). Leaves of *Sesbania grandiflora* was taken from trees grown in Pasir Mas while *Gliricidia maculata* was taken from Jeli. The material and apparatus that had been used throughout the experiment was listed in the Table 3.1.

Figure 3.2: BRIS soil was taken from Bachok, Kelantan

Figure 3.3: Activity mixing and sieving process

Table 3.1: List of all the apparatus and materials

Apparatus	Materials
1. Polybags (8 cm × 20 cm) 500g	1. BRIS soil (20 kg)
2. Wheelbarrow	2. Seed of groundnut
3. Laboratory oven	3. Water (15 liters)
4. Shovel	4. *Sesbania grandiflora* leaves
5. Barbed wire (20 m)	5. *Gliricidia maculata* leaves
6. Mulch plastic sheet (3 m × 3 m)	6. Insecticides (50 ml)
7. Netting black	7. Molluscides (50 g)
8. Ruler	
9. Caliper digital	
10. Hoe	
11. Weighing scale	
12. Soil moisture meter	
13. Measuring cylinder	

3.3 Methods

A 2×3×1 factorial experiment was carried out. The experiment involved of three treatments. For first treatment, two different species of leaves were used as green manure which is *Sesbania grandiflora* and *Gliricidia maculata*. Second treatment is germination media (volume/volume) which consisted of three different ratios of BRIS soil and green manure which is 1:0, 1:1, and 3:1. This germination media were separated between BRIS soil with *Sesbania grandiflora* and BRIS soil with *Gliricidia maculata*. Then, 30% of field capacity for soil moisture level was used as a third treatment. It was measured using soil moisture meter. The treatments involve are shown in the Table 3.2.

Table 3.2: Factor that involves in the experiment treatment

No	Treatment	Description
1	Green manure	*Sesbania grandiflora* leaves, *Gliricidia maculata* leaves
2	Germination media	Ratio 1:0 (1 BRIS soil) Ratio 1:0 (1 BRIS soil) Ratio 1:1 (1 BRIS soil : 1 *Sesbania grandiflora* leaves) (1 BRIS soil : 1 *Gliricidia maculata* leaves) Ratio 3:1 (3 BRIS soil : 1 *Sesbania grandiflora* leaves) (3 BRIS soil : 1 *Gliricidia maculata* leaves)
3	Soil moisture	30% field capacity

3.3.1 Preparation of soil media or potting mixture

3.3.1.1 Soil treatment

The first stage in this experiment is the leaves of *Sesbania grandiflora* and *Gliricidia maculata* was dried and then cut into a small size respectively. BRIS soil that was blended with *Sesbania grandiflora* and BRIS soil with *Gliricidia maculata* using variation of ratio needed and put into polybags. The ratio weight per weight was used 1:0, 1:1 and 3:1. Each of the ratio was replicated four times. The total of polybags is 24 altogether where 12 for BRIS soil mixed with *Sesbania grandiflora* and 12 for BRIS soil mixed *Gliricidia maculata* as a medium. Polybags placed at the distance of 5cm between each other.

3.3.2 Determination of soil moisture

3.3.2.1 Soil water content

The soil mixed with *Sesbania grandiflora* or *Gliricidia maculata* need to be determined its field capacity moisture content using soil moisture meter. Thus, suitable time for watering schedule can be determined.

3.3.3 Seed pre-treatment

For the experiment, uniform size of *A. hypogaea* was chosen then soaked in distilled water for 24 hours (Neelamegam & Sutha, 2015). *A. hypogaea* seeds have a same size, in a good quality and no wrinkled were chosen in this experiment. The seed was soaked in distilled water for 24 hours. Soaking seed in water before sowing to soften the outer skin of seed *A.hypogaea*. It allowed the seed become soft and easy to germinate.

3.3.4 Seed sowing process

A seed will be sown about 5-6 cm in the soil (Singh & Oswalt, 1995). A seed was sown about 5cm in the soil and watering schedule based on the result from the determination of moisture content in BRIS soil. Weeding, fungicides and insecticides applications will be made when necessary.

3.3.5 Complete Randomization Design (CRD)

Experiment were arranged in Completely Randomized Design (CRD). The polybags were labelled according to the Table 3.3. T represented as treatment and R as replication.

Table 3.3: Layout design for Completely Randomized Design (CRD)

Type of green manures	Media	Label
Sesbania grandiflora	Ratio 1:0 (T1)	T1R1, T1R2, T1R3, T1R4
	Ratio 1:1 (T2)	T2R1, T2R2, T2R3, T2R4
	Ratio 3:1 (T3)	T3R1, T3R2, T3R3, T3R4
Gliricidia maculata	Ratio 1:0 (T4)	T4R1, T4R2, T4R3, T4R4
	Ratio 1:1 (T5)	T5R1, T5R2, T5R3, T5R4
	Ratio 3:1 (T6)	T6R1, T6R2, T6R3, T6R4

The layout for the experiment were arranged according to the Tables of Random Number (Beyer, 1968). The first number in the Table of Random Numbers is considered as the starting point. The last two digit numbers represented the number of the polybags. The number for layout arrangement was chosen without any repetition or replacement. Beginning from the left of the top row of the Random Number Table as shown in the Figure 3.4, the two last digits that appeared with a similar number as labelled at the polybags will be chosen. The selection continued until all the samples are included for the field layout arrangement. It sorted from top to bottom.

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

Figure 3.4: Table of Random Number (Beyer, 1968)

Sources: Handbook of Tables for Probability and Statistics, 2nd Edition, edited by William H.Beyer (Cleveland: The Chemical Rubber Company, 1968)

Table 3.4: Layout of arrangement using Complete Randomized Design

T1R1	T1R3	T3R4	T1R4	T6R4	T1R2
T4R3	T5R1	T5R2	T4R2	T6R1	T2R4
T4R1	T5R3	T6R3	T3R1	T4R4	T2R3
T2R1	T6R2	T2R2	T3R3	T3R2	T5R4

**T= Treatment, R=Replication*

3.3.6 Collecting data

All of the germinated seed were counted and percentage of germination calculated.

Formula:

$$\%\ GP = \frac{seed\ germinated}{total\ seed} \times 100\ \% \quad \text{(Equation 3.1)}$$

The growth of *A.hypogaea* seedlings is monitored by measuring height, diameter at monthly interval. At the end of the experiment, all of the plant was uprooted then washed to know the biomass. (Pommerening & Muszta, 2015).

Formula:

Relative growth rate

$$RGR = \frac{(\ln w_2 - ln\ w_1)}{(t_2 - t_1)} \quad \text{(Equation 3.2)}$$

Where:

ln = natural logarithm

w_2 = initial dry weight of plant at t_2 (gram)

w_1 = initial dry weight of plant at t_1 (gram)

t_2 = time of experiment end (day)

t_1 = time of experiment starts (day)

RGR = relative growth rate

3.3.7 Plants growth observations

Plant height, total number of leaves, stem diameter and biomass were determined on plant in each replication. This parameter was measured week by week for two months. The data was recorded and calculated the mean of each treatment.

3.3.7.1 Plant height

Data were measured every week on height of plants. Data on height was measured from soil level to highest shoot. Ruler were used to measure this height.

3.3.7.2 Total number of leaves

Leaf number was counted when the leaf was visible. Each leaf number out from the saplings was counted.

3.3.7.3 Diameter of plant

The measurement of initial and final diameter were recorded by using a digital caliper. A digital caliper was used to measure the diameter of this plants (Hossain et al., 2011).

3.3.8 Dry biomass

The dry biomass of the plants was obtained after two months carrying out the experiment. The plants including roots were removed from the polybags and were cleaned before putting the plants into the laboratory oven at the temperature of 65°C for 48 hours until the mass remains unchanged was obtained (Hossain et al., 2011). Plant components were separated between top and bottom of plant. The data obtained was recorded for analysis.

3.3.9 Statistical analysis

According by (SAS Institute Inc., 1990; Nur et al., 2015) all the data collected were subjected to Analysis of Variance (ANOVA) using General Linear Models (GLM) procedures on Minitab 17 Software (Minitab Inc. USA). The results are considered significant at 5% probability test. Then proceeded with the post-hoc test, Tukey's Test to differentiate the mean value between the interaction of the treatments. Aimed at comparisons with the post-hoc test, Tukey's Test is to identify the most effective factors on means of parameter.

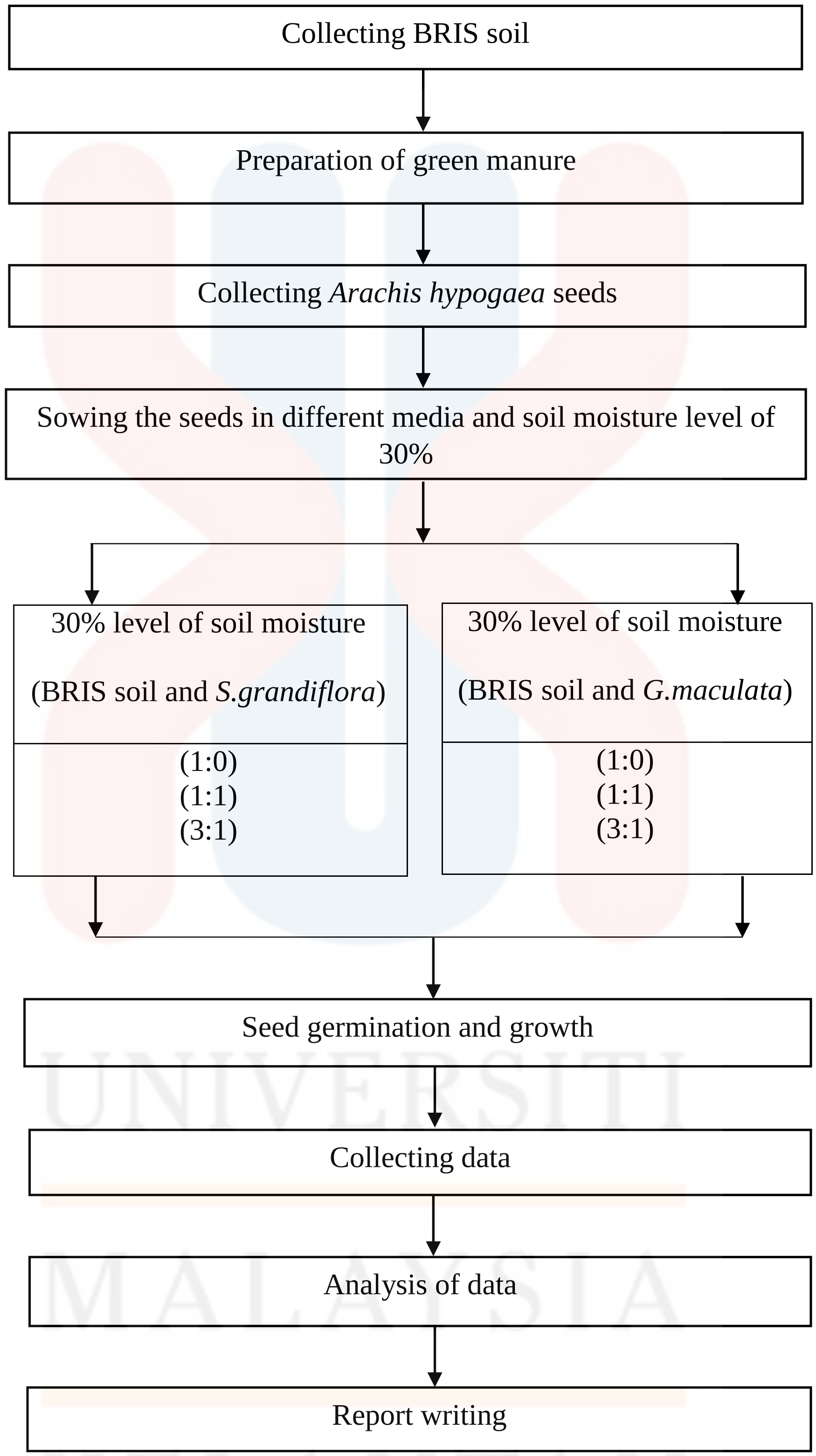


Figure 3.5: Summary of methodology

CHAPTER 4

RESULTS AND DISCUSSION

Based on abbreviation used in this chapter, Table 4.1 was to assist the reader about the treatment that used.

Table 4.1: Abbreviation of treatments

Treatment	Abbreviation
T1	1 BRIS soil: 0 *Sesbania grandiflora*
T2	1 BRIS soil: 1 *Sesbania grandiflora*
T3	3 BRIS soil: 1 *Sesbania grandiflora*
T4	1 BRIS soil: 0 *Gliricidia maculata*
T5	1 BRIS soil: 1 *Gliricidia maculata*
T6	3 BRIS soil: 1 *Gliricidia maculata*

4.1 Soil texture

Soil texture is one of important physical properties of soils. It is determined by the size and type of particles that make up the soil (Brady & Weil, 2008). The important of soil characteristics such as soil fertility, soil drainage and water holding capacity are related to soil texture. In this experiment, method used for determining soil texture quantitatively is known as the mechanical analysis method. The analysed soil samples, give the reading of BRIS soil of 92.4% sand, 4.8% silt and 2.8% clay. Based on Figure 4.1, soil texture pyramid, it shows BRIS soil is a sand.

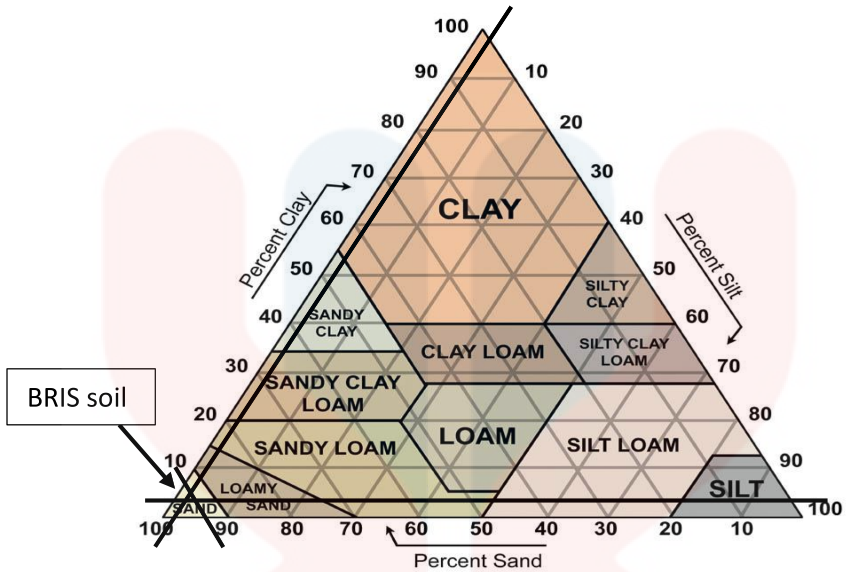


Figure 4.1: Soil Texture Pyramid

Sources: http://www.soilsensor.com

4.2 Percentage of seed germination

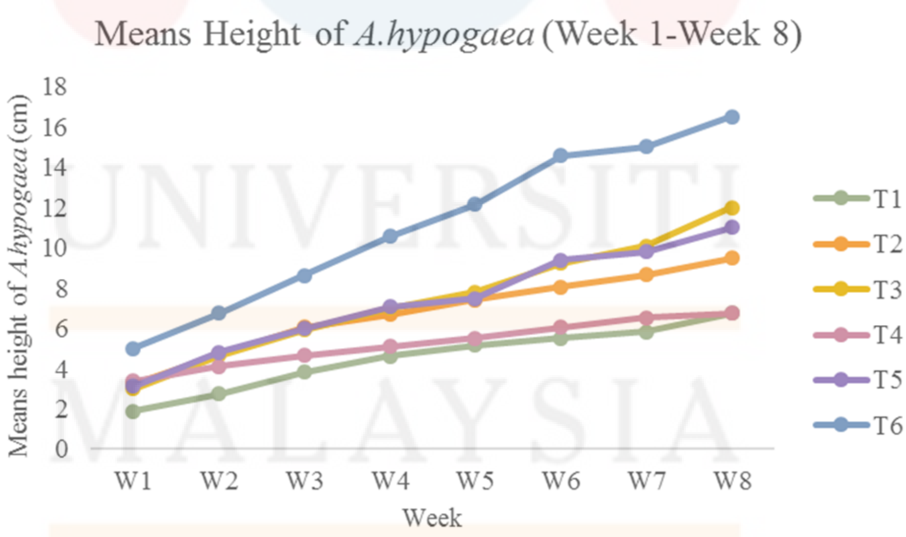
In the experiment, *A.hypogaea* seeds were soaked in distilled water for 24 hours and through the 10 days observation period, the results showed that the average germination of seeds was greater than 87.33% percentage. Ottman (2000) mentioned that 85.00% percentage as certified seed and this indicates that the seeds were of good quality and viable.

4.3 The growth performance analysis

Growth performance define as a changes of size or stage of maturation often over a period time. Through this experiment, green manures (*Sesbania grandiflora* and *Gliricidia maculata* leaves) were used as a treatment on BRIS soil to generally promoted growth of *Arachis hypogaea*. Detailed ANOVA is given in Appendix C.

4.3.1 Height of *Arachis hypogaea*

Plant height showed significant differences effect of media on *A.hypogaea*. On the 10th day after emergence, plant heights showed an increasing trend in all treated plants with values ranged from 1.90 to 5.00 cm. The mean height from Week 1 to Week 8 is given in Figure 4.2.



Note: T1-T6=Treatments, W1-W8=Week

Figure 4.2: The graph means height of A. hypogaea (Week 1-Week 8)

In term of height growth, the treatments can be arranged in the order of T6 > T3 > T5 > T2 > T4 > T1 (Figure 4.2). Treatment 6 (3 BRIS soil : 1 *Gliricidia maculata* leaves) gave the highest mean height for every week. This might due to the effects of soil and *Gliricidia maculata* leaves that retained nutrient pools from where plants could able to extract sufficient nutrients.

Treatment 1 (1 BRIS soil : 0 *Sesbania grandiflora* leaves) gave the lowest mean height due to absence of green manure in the BRIS soil. Figure 4.3 (a), (b) and (c) shows the mean height of *A.hypogaea* for Week 1, Week 4 and Week 8.

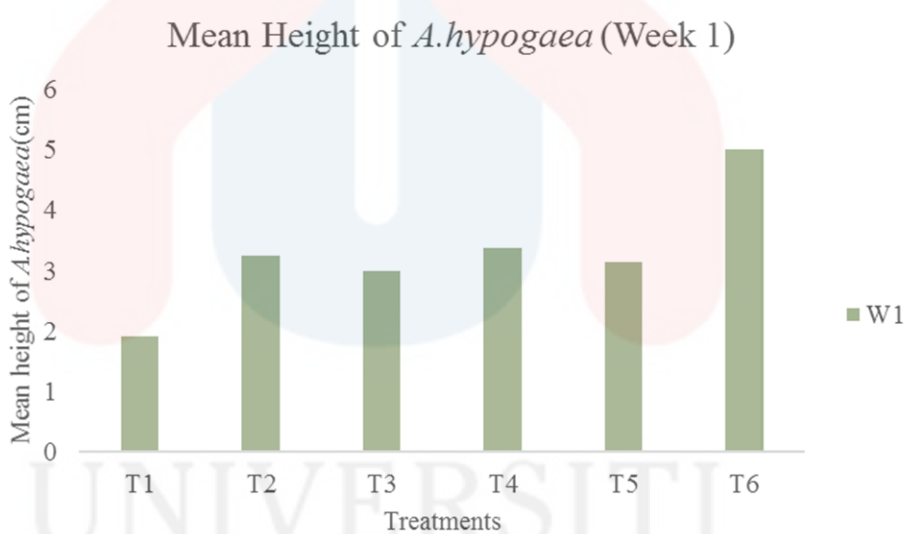


Figure 4.3 (a): The graph means height of *A.hypogaea* Week 1

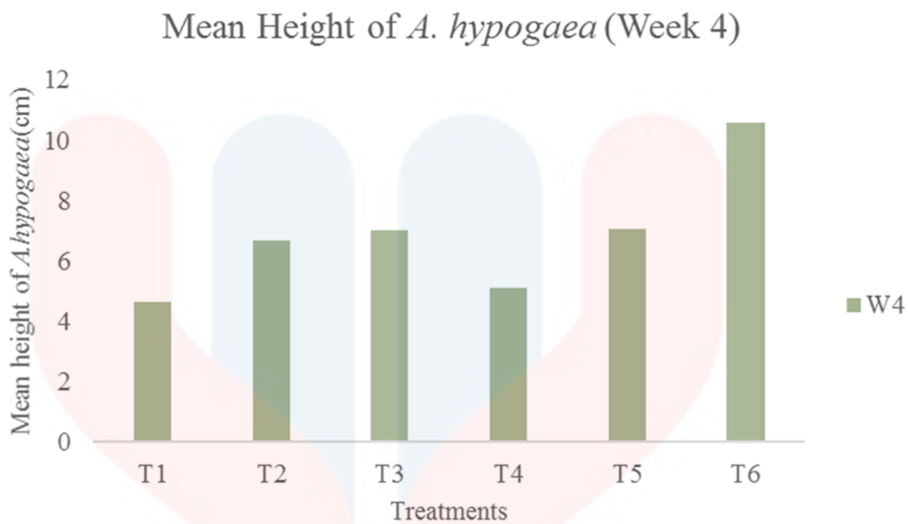


Figure 4.3 (b): The graph means height of *A.hypogaea* Week 4

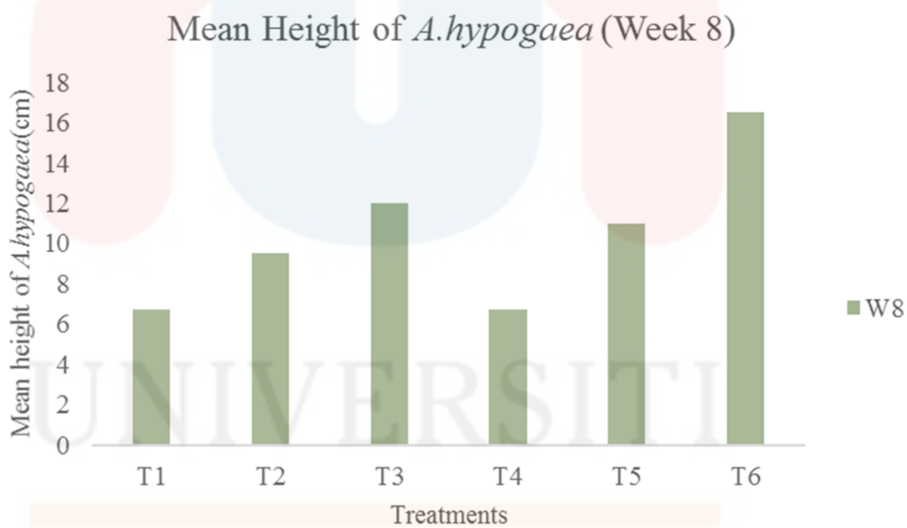


Figure 4.3 (c): The graph means height of *A.hypogaea* Week 8

From ANOVA (Table 4.2), height for Week 1, shows that treatment had no significant effect on the plant growth (Media: P = 0.303, Green manure: P = 0.128, Media x Green manure: P = 0.451). While, Week 4 only Media is significant value (P = 0.007) (Table 4.3). Similarly, at Week 8, only Media has significantly effect on height of *A.hypogaea* (P = 0.000) (Table 4.4). At both 4 and 8 Weeks, Green manure seemed to have no significant effect height growth (Week 4, P = 0.111; Week 8, P = 0.115). The interaction between Media x Green manure showed no significant effect at Week 4 (P = 0.273) and Week 8 (P = 0.324).

Table 4.2: Analysis of Variance (ANOVA) for height of *A.hypogaea* (Week 1)

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	**F-Value**	**P-Value**
Media	2	7.517	3.759	1.28	0.303n.s
Green manure	1	7.482	7.482	2.54	0.128n.s
Media x Green manure	2	4.901	2.450	0.83	0.451n.s
Error	18	52.985	2.944		
Total	23	72.885			

*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 of *A.hypogaea* (Week 4)

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	**F-Value**	**P-Value**
Media	2	61.64	30.818	6.56	0.007**
Green manure	1	13.20	13.202	2.81	0.111n.s
Media x Green manure	2	13.13	6.565	1.40	0.273n.s
Error	18	84.53	4.696		
Total	23	172.50			

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

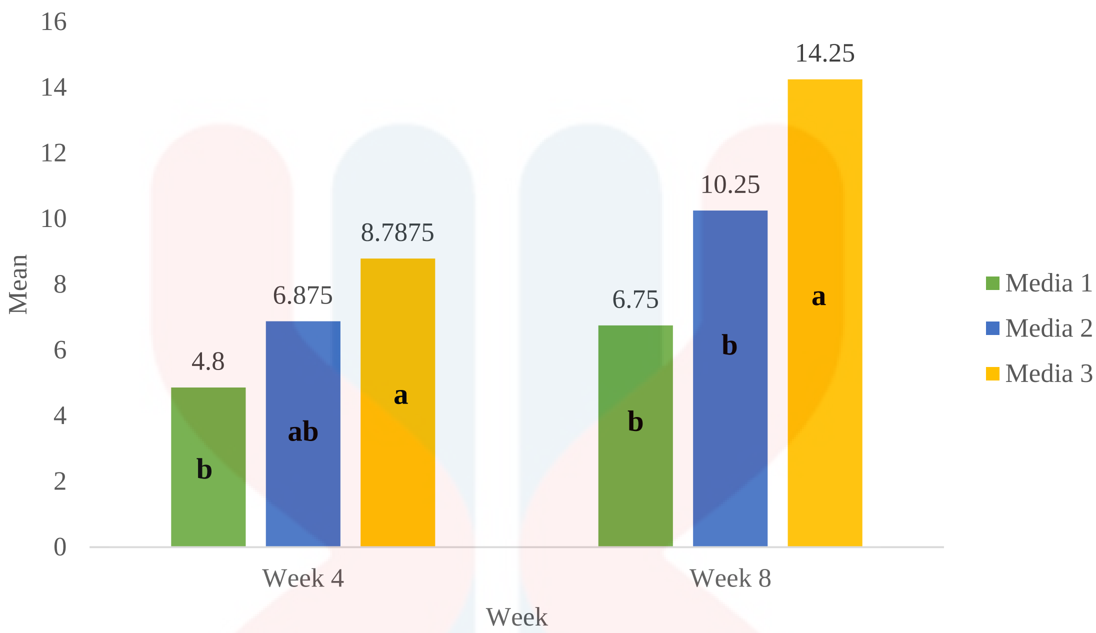
Table 4.4: Analysis of Variance (ANOVA) for height of *A.hypogaea* (Week 8)

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	**F-Value**	**P-Value**
Media	2	225.33	112.667	12.88	0.000**
Green manure	1	24.00	24.000	2.74	0.115n.s
Media x Green manure	2	21.00	10.500	1.20	0.324n.s
Error	18	157.50	8.750		
Total	23	427.83			

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

Tukey Pairwise Comparison was used to further analyses the significant data from two-ways ANOVA in other to further specify the main factor that effected the response. Factors that contributed were Media and Green manure. It shows that the Media gave significantly effect on height ($P < 0.001$). Figure 4.4 represent the comparisons of Media on different treatment at Week 4 and Week 8. Its shows that Media 3 of both type of manure, *Sesbania grandiflora* and *Gliricidia maculata* (3 BRIS soil : 1 green manure leaves) gave the highest mean height growth in *A.hypogaea*.

However, Green manure type shown no significant effect (Week 4, $P = 0.111$; Week 8, $P = 0.115$). This may due to the type of green manure which are *Sesbania grandiflora* and *Gliricidia maculata* is more or less similar value of nutrient level on *A.hypogaea* and treatment on BRIS soil. Based on Figure 4.4, Week 4 and Week 8 shows the mean Media 3 highest than Media 1 and Media 2. At Week 4, there was significantly difference between Media 1 and Media 3 while Week 8, Media 3 is significantly difference with Media 1 and Media 2 (Figure 4.4). This may due the condition environmental factor influences affecting the height of *A.hypogaea*.



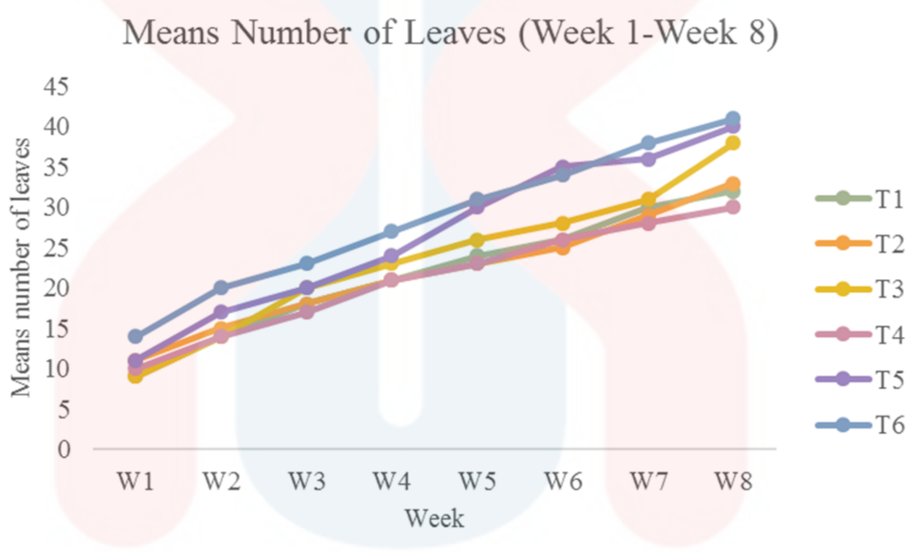
(Note: Bars with similar letter are not significantly difference at p<0.05)

**Media 1=Ratio 1:0, Media 2=Ratio 1:1, Media 3=Ratio 3:1*

Figure 4.4: The effect of Media on different treatment on height of *A.hypogaea* with Tukey Pairwise Comparison (Week 4 and Week 8)

4.3.2 Total leaves number

Total leaves number was counted from the saplings. There is no interaction between Media and Green manures on total leaves number. Previous study by Reddy and Matcha (2010) as mention by Hossain et al., (2012), the major factor that effect photosynthesis of the plants is plant height and number of leaves.



Note: T1-T6=Treatments, W1-W8=Week1-8

Figure 4.5: The graph means of total leaves number (Week 1- Week 8)

In term of mean number of leaves from Week 1 to Week 8, the treatments can be arranged in order of T6 > T5 > T3 > T2 > T1 > T4 (Figure 4.5). Treatment 6 is the highest the mean of total leaves number may due to the *Gliricidia maculata* leaves covered the ground well with suitable nutrients and space. Figure 4.6 (a), (b) and (c) shows the mean number of leaves for Week 1, Week 4 and Week 8.

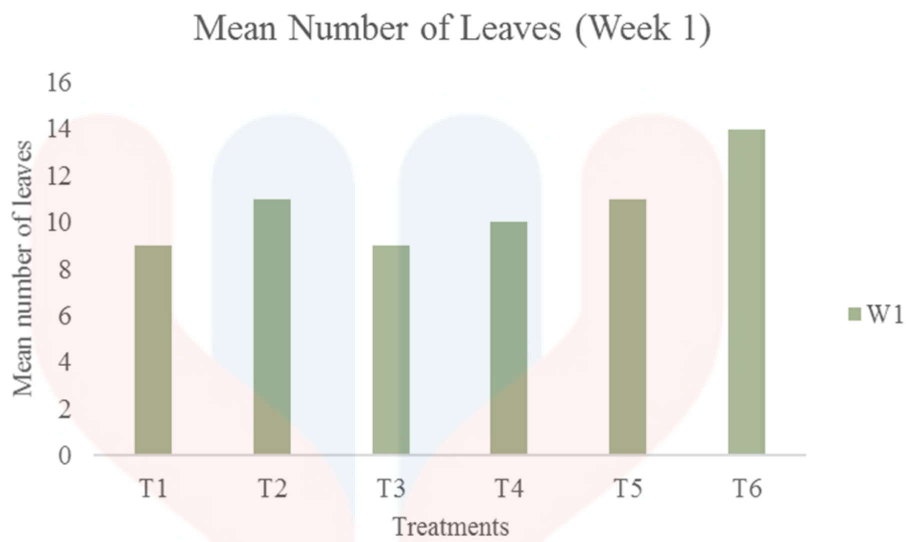


Figure 4.6 (a): The graph means number of leaves *A. hypogaea* Week 1

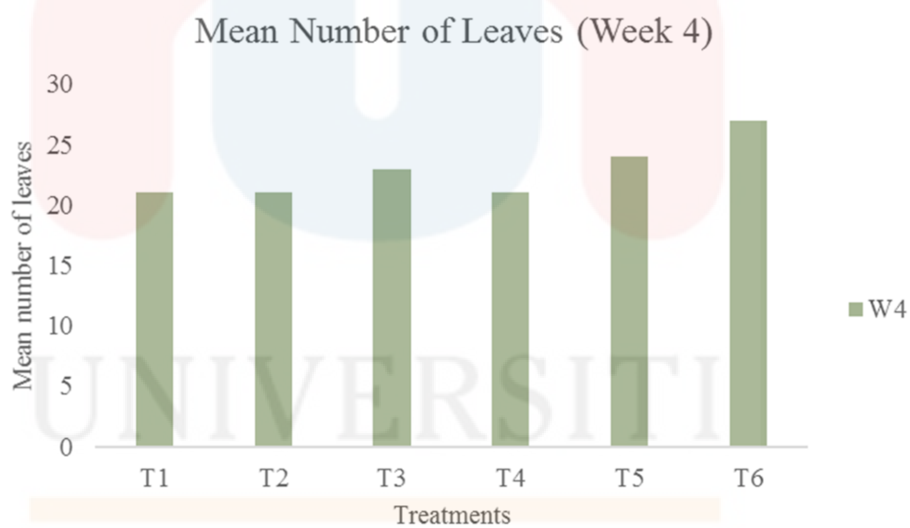


Figure 4.6 (b): The graph means number of leaves *A.hypogaea* Week 4

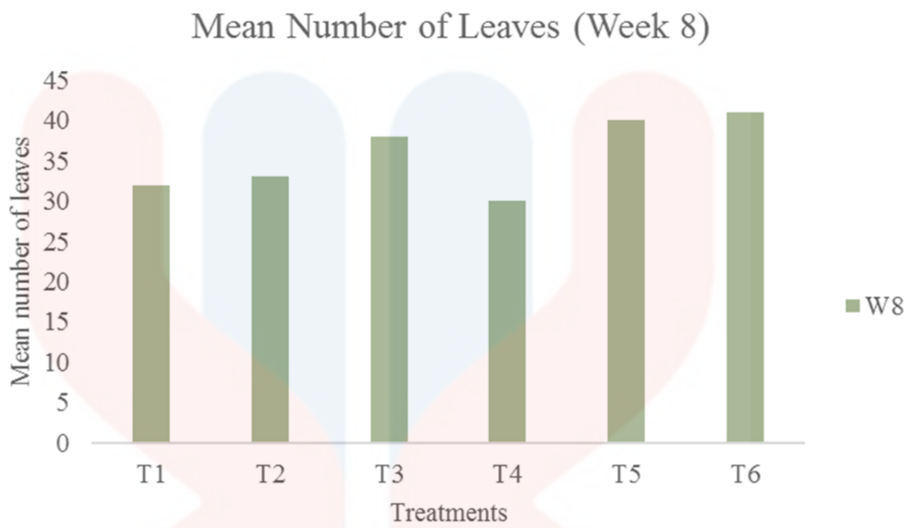


Figure 4.6 (c): The graph means number of leaves *A.hypogaea* Week 8

Based on ANOVA, total leaves number for Week 1, the graph shows treatment had no significant effect on the plant growth (Media: P = 0.429, Green manure: P = 0.135, Media x Green manure: P = 0.265) (Table 4.5). Based on previous study by Kelly (2011), low organic matter causing N deficiency symptom on the plant the older leaves hence plants loss their leaves to regenerate new leaves. Similarly, Week 4 also had no significant (Media: P = 0.241, Green manure: P = 0.231, Media x Green manure: P = 0.671) (Table 4.6).

However, at Week 8, only Media has significantly effect on total number leaves of *A.hypogaea* (P = 0.024) (Table 4.7). While Green manure at Week 8 seemed to have no significant effect on total number of leaves (P = 0.265). Interaction between Media x Green manure showed no significant effect (P = 0.307). It indicates the Media as the most effective factor for increasing the total leaves number.

Table 4.5: Analysis of Variance (ANOVA) for total leaves number (Week 1)

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	17.33	8.667	0.89	0.429n.s
Green manure	1	24.00	24.000	2.45	0.135n.s
Media x Green manure	2	28.00	14.000	1.43	0.265n.s
Error	18	176.00	9.778		
Total	23	245.33			

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

Table 4.6: Analysis of Variance (ANOVA) for total leaves number (Week 4)

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	65.33	32.667	1.54	0.241n.s
Green manure	1	32.67	32.667	1.54	0.231n.s
Media x Green manure	2	17.33	8.667	0.41	0.671n.s
Error	18	382.00	21.222		
Total	23	497.33			

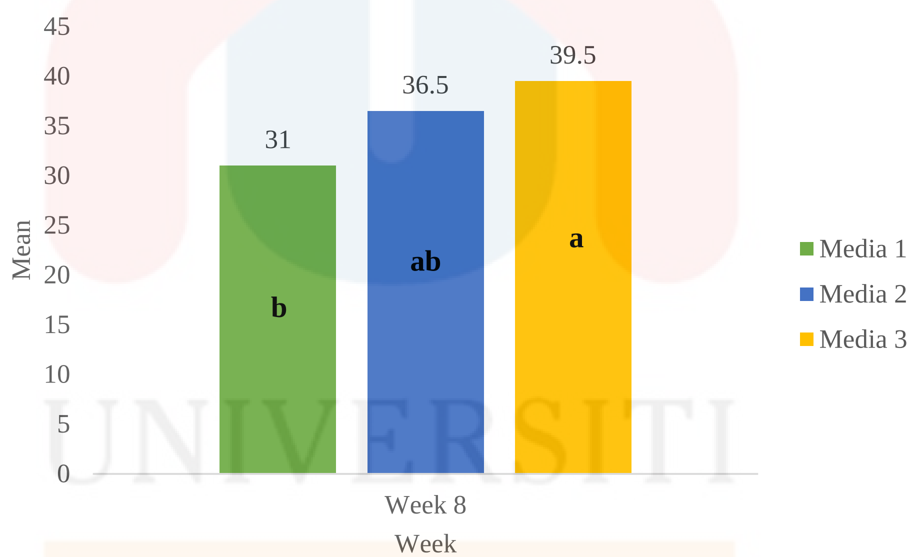
*Note: *=significant difference (P<0.05), **=highly significant difference (P<0.001), n.s = not significant (P>0.05)*

Table 4.7: Analysis of Variance (ANOVA) for total leaves number (Week 8)

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	297.33	148.67	4.61	0.024*
Green manure	1	42.67	42.67	1.32	0.265n.s
Media x Green manure	2	81.33	40.67	1.26	0.307n.s
Error	18	580.00	32.22		
Total	23	1001.33			

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

Through Tukey Pairwise Comparison, Figure 4.7 shows only Media at Week 8 gave significant effect on total leaves number ($P < 0.05$). It show that Media 3 of both type of manure, *Sesbania grandiflora* and *Gliricidia maculata* (3 BRIS soil : 1 green manure leaves) gave the highest mean of total leaves number of *A.hypogaea*. This may be due only one seeds *A.hypogaea* sown in polybag and have sufficient essential plant nutrient, it can increase the number of leaves. Either macronutrient or micronutrients, it is important for *A.hypogaea* growth. The bar chart below shows Media 3 was significant difference with Media 1. There was no significant difference with Media 2.



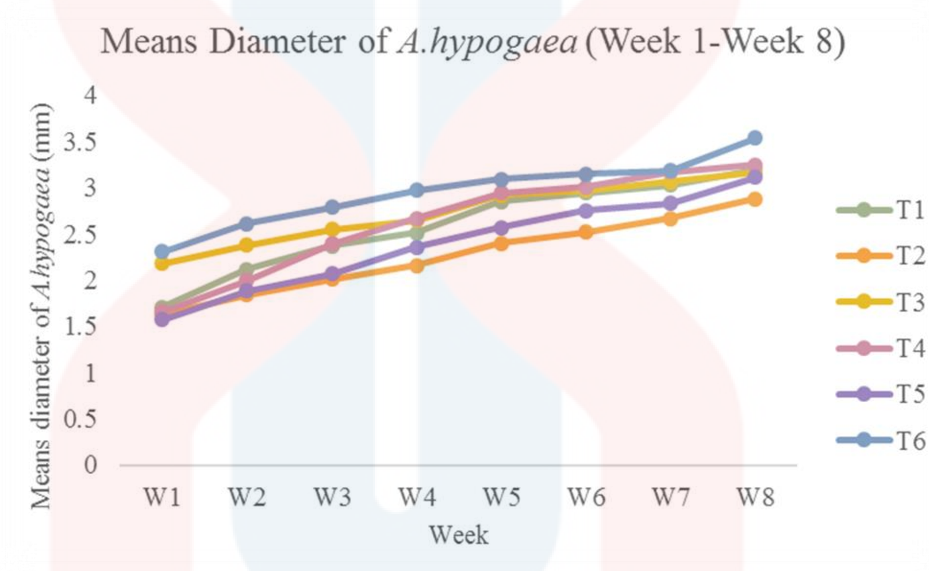
(Note: Bars with similar letter are not significantly difference at $p<0.05$)

**Media 1=Ratio 1:0, Media 2=Ratio 1:1, Media 3=Ratio 3:1*

Figure 4.7: The effect Media on leaves number with Tukey Pairwise Comparison (Week 8)

4.3.3 Diameter of *Arachis hypogaea*

The results show a slow increase from Week 1 until Week 8. It only a small diameter because it takes only two months to collect data. Previous study by Prasad et al., (2009), *Arachis hypogaea* early maturing about 90 to 120 days depending on the variety.



Note: W1-W8 = Week 1-8, T1-T6=Treatment

Figure 4.8: Means of diameter of *A.hypogaea* (Week 1-Week 8)

Figure 4.8 indicates mostly the diameter of plant showed the slow increasing trend of diameter growth performance. It is because *A.hypogaea* from annual herbaceous plants that grow upwards elongation and have short period of time that conducted the experiment. In term of diameter *A. hypogaea*, the treatments can be arranged in order of T6 > T4 > T3 > T1 > T5 > T2. Treatment 6 has highest diameter reading from Week 1 until Week 8. When the plant grew taller, then the stem became stronger and bigger. Whereas, Treatment 2 has the minimum reading of plant diameter. This is because the media contained less organic matter to support nutrient for the plant. Figure 4.9 (a), (b) and (c) below shows the means of diameter *A.hypogaea* between Week 1, Week 4 and Week 8.

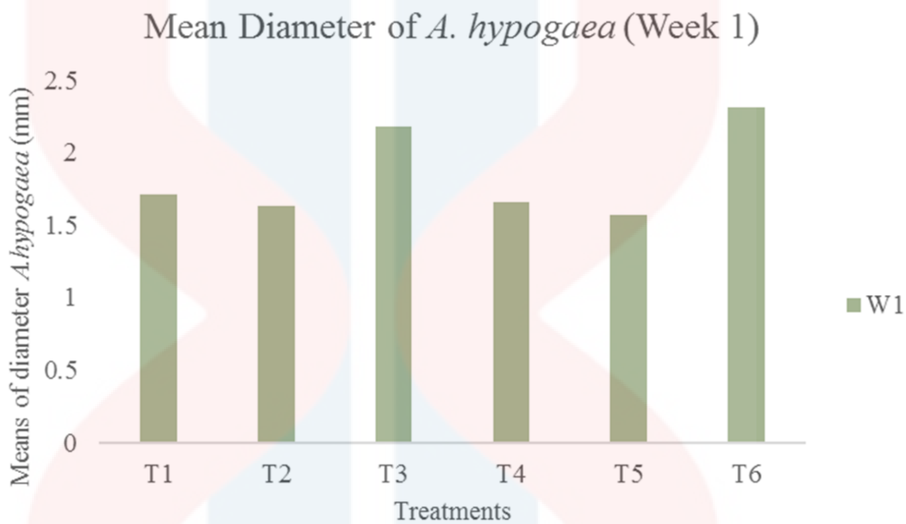


Figure 4.9 (a): The graph means diameter of *A.hypogaea* Week 1

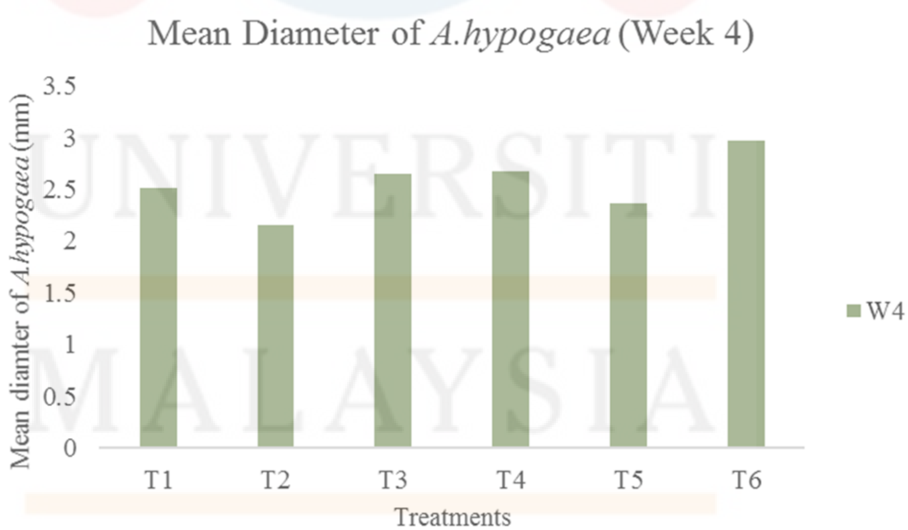


Figure 4.9 (b): The graph means diameter of *A.hypogaea* Week 4

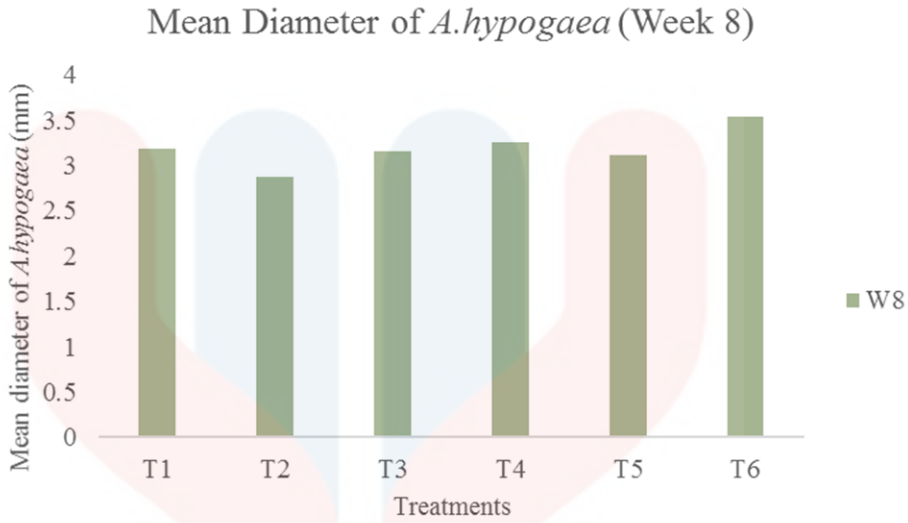


Figure 4.9 (c): The graph means diameter of *A.hypogaea* Week 8

From the ANOVA, stem diameter for Week 1, it shows that only Media had significant effect on the plant growth (Media: P = 0.004, Green manures: P = 0.946, Media x Green manure: P = 0.830) (Table 4.8). While, Week 4 had no significant difference (Media: P = 0.075, Green manure: P = 0.237, Media x Green manure: P = 0.936) (Table 4.9). Similarly, at Week 8, Media and Green manure have no significantly effect on diameter of *A.hypogaea* (Media: P = 0.344, Green manure: P = 0.256, Media x Green manure: P = 0.802) (Table 4.10).

Table 4.8: Analysis of Variance (ANOVA) for diameter of *A.hypogaea* (Week 1)

Source	**Degree of Freedom**	**Sum Square**	**Mean Square**	**F-Value**	**P-Value**
Media	2	1.95523	0.977617	7.82	0.004**
Green manure	1	0.00060	0.000600	0.00	0.946n.s
Media x Green manure	2	0.04710	0.023550	0.19	0.830n.s
Error	18	2.25080	0.125044		
Total	23	4.25373			

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

Table 4.9: Analysis of Variance (ANOVA) for diameter of *A.hypogaea* (Week 4)

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	1.22763	0.61382	3.00	0.075n.s
Green manure	1	0.30600	0.30600	1.50	0.237n.s
Media x Green manure	2	0.02723	0.01362	0.07	0.936n.s
Error	18	3.67763	0.20431		
Total	23	5.23850			

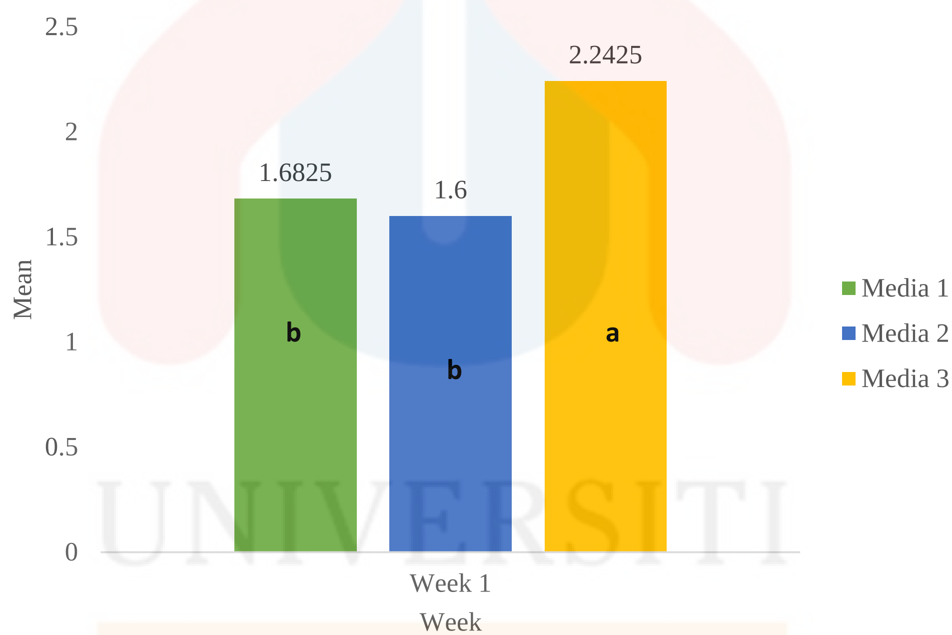
*Note: *=significant difference (P<0.05), **=highly significant difference (P<0.001), n.s = not significant (P>0.05)*

Table 4.10: Analysis of Variance (ANOVA) for diameter of *A. hypogaea* (Week 8)

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	0.49761	0.24880	1.13	0.344n.s
Green manure	1	0.30150	0.30150	1.49	0.256n.s
Media x Green manure	2	0.09776	0.04888	0.22	0.802n.s
Error	18	3.94862	0.21937		
Total	23	4.84550			

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

Figure 4.10 represent only Media at Week 1 gave significant effect on diameter (P < 0.05). It showed that Media 3 of both type of green manure, *Sesbania grandiflora* and *Gliricidia maculata* (3 BRIS soil: 1 green manure leaves) gave the maximum mean of diameter *A.hypogaea*. This may due to *A.hypogaea* is a kind of herbaceous plant which grow upwards rather than widens. Therefore, the reading of diameter did not increased excessively. At Week 1 (Figure 4.10), Media 3 is significant difference with Media 1 and Media 2.



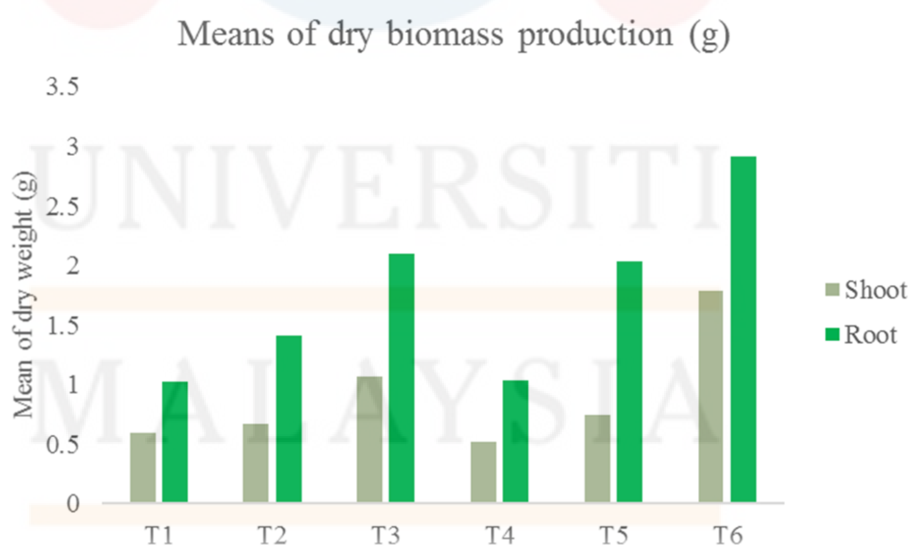
(Note: Bars with similar letter are not significantly difference at p<0.05)

**Media 1=Ratio 1:0, Media 2=Ratio 1:1, Media 3=Ratio 3:1*

Figure 4.10: The effect Media on diameter *A.hypogaea* with Tukey Pairwise Comparison (Week 1)

4.4 Dry biomass production

At the end of experiment, *A. hypogaea* was cut into two different portions – root and shoot were entering into oven about 65°C for 48 hours for measure first reading. Previous study by Hossain et al., (2011) mentioned that temperature of oven-dried about 65°C. Time took for five days to obtain the production of dry biomass to remain constant weight. The data obtained for dry biomass of *A.hypogaea* is expressed in gram form. Based on Figure 4.11, at day 5 dry biomass of *A.hypogaea* can be arranged in order of T6 > T3 > T5 > T2 > T1 > T4 arrangement. Treatment 6 has highest biomass production because size of *A.hypogaea* is larger than other five treatments and Treatment 6 has highest mean for all of parameter were measured. From the data of dry weight, Relative Growth Rate (RGR) can be calculated.



Note: T1-T6=Treatment

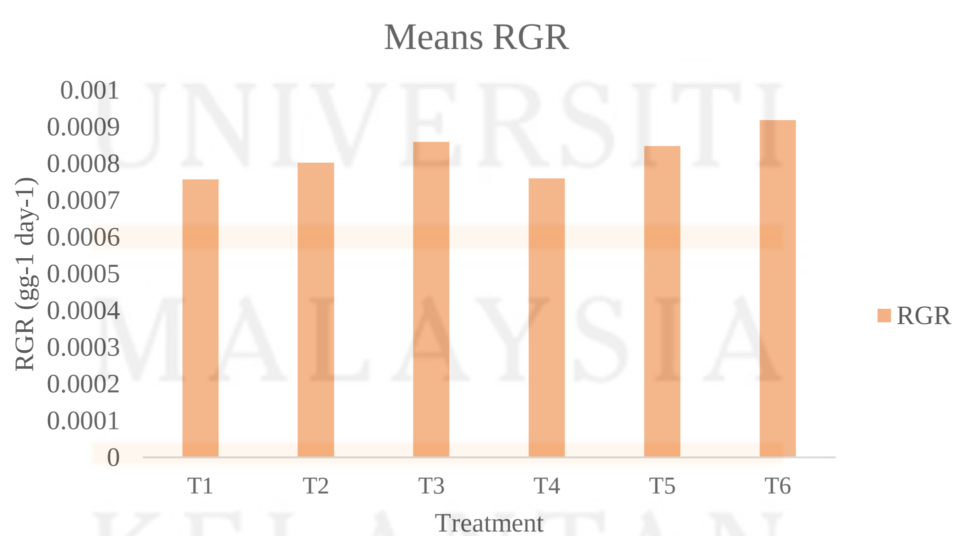
Figure 4.11: Mean dry biomass of *A.hypogaea*

4.5 Relative growth rate

At the end of the experiment, Relative Growth Rate (RGR) *of A.hypogaea* was calculated. Table 4.11 shows that Treatment 6 has the highest mean value of Relative Growth Rate on the other hand, Treatment 1 showed the lowest mean value of relative growth rate.

Table 4.11: Mean of Relative Growth Rate (RGR)

Treatment	Mean Relative Growth Rate (g $g^{-1}day^{-1}$)
T1	0.000757
T2	0.000803
T3	0.000859
T4	0.000760
T5	0.000848
T6	0.000919



Note: T1-T6 = Treatment

Figure 4.12: Mean of Relative Growth Rate (RGR)

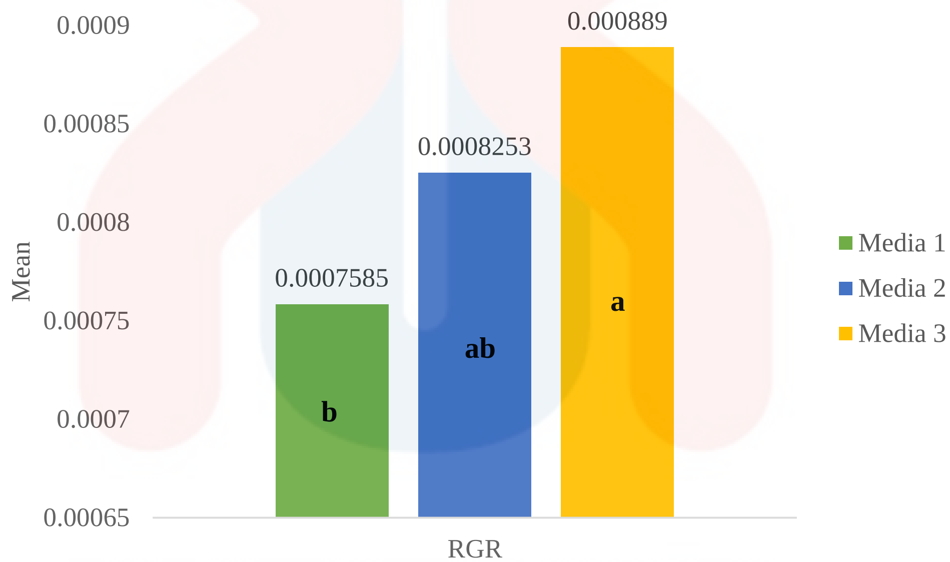
From Figure 4.12, Treatment 6 show the highest mean of RGR followed by Treatment 3. The figure indicates that the higher the mean of RGR, the faster the growth of *A.hypogaea*. While, Treatment 4 followed by Treatment 1 is the lowest mean of RGR because of absence the treatment on BRIS soil. From ANOVA, Relative Growth Rate (RGR) shows that only Media had significant effect on this plant growth (Media: P = 0.002, Green manures: P = 0.172, Media x Green Manure: P = 0.640).

Table 4.12: Analysis of Variance (ANOVA) for Relative Growth Rate

Source	Degree of Freedom	Sum Square	Mean Square	F-Value	P-Value
Media	2	0.000000	0.000000	8.96	0.002*
Green manure	1	0.000000	0.000000	2.03	0.172n.s
Media x Green manure	2	0.000000	0.000000	0.46	0.640n.s
Error	18	0.000000	0.000000		
Total	23	0.000000			

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

Figure 4.13 represent the comparisons of Media on different treatment for Relative Growth Rate (RGR). The result shows that only Media gave significant effect on RGR ($P < 0.05$). It shows that Media 3 of both type of green manure, *Sesbania grandiflora* and *Gliricidia maculata* (3 BRIS soil : green manure leaves) gave the highest value Relative Growth Rate of *A.hypogaea*. However, green manure type shown no significant effect ($P = 0.172$). Based Figure 4.13 below, Media 3 is significant difference with Media 1 and Media 2.



(Note: Bars with similar letter are not significantly difference at p<0.05)

**Media 1=Ratio 1:0, Media 2=Ratio 1:1, Media 3=Ratio 3:1*

Figure 4.13: The effect of Media on different treatment on Relative Growth Rate with Tukey Pairwise Comparison

4.6 Pest and disease

Pest in Figure 4.14 shows the hole appearance on *A.hypogaea* leaves. This might due to the grasshopper or larvae of a small moth bite the leaves. The number of leaves decrease about five because the insect bite whole surface of the leaf.

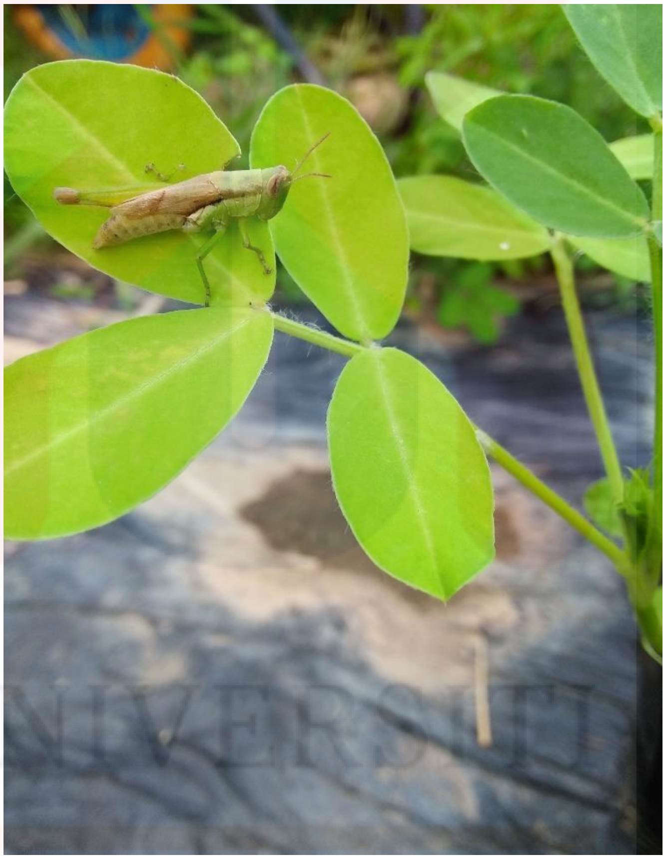


Figure 4.14: Grasshopper was spotted on the leaf of *A.hypogaea*

Figure 4.15 shows the leaves rust on *Arachis hypogaea* leaves. This sign occurs after three weeks planting. Symptoms of leaves rust occurs two to three weeks after planting (N2Africa, 2014). At the beginning, has sign one or more leave started to fall into soil. A change of dark brown colour is a rust leaves contributed by the fungus.

Figure 4.15: Rust leaves on *Arachis hypogaea* leaves

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the results this study, the effect of different amount of BRIS soil on *Arachis hypogaea* growth show the different result for each parameter. Based on ANOVA analysis, only Media that had significant in this experiment. For the factor of Green manure, the comparison between the type of green manure which are *Sesbania grandiflora* and *Gliricidia maculata* is more or less similar value of nutrient level on *A.hypogaea* and treatment on BRIS soil. In addition, it can be further concluded that Treatment 6 show the best of the growth performance in all parameters which is the plant height, the leaves number, stem diameter and also dry biomass.

The result of ANOVA for height *A. hypogaea* where only week 4 and week 8 showed significant value on media which are week 4 (P=0.007) and week 8 (P=0.000). Total number of leaves showed week 8 has significant value which is P=0.024 on media. Stem diameter showed week 1 has significant value on media P=0.004. Then RGR showed significant value on media P=0.002. No significant value was recorded for green manure as a treatment.

From the result obtained, the use of green manure and the best ratio (3 BRIS soil: 1 *Gliricidia maculata*) is needed in improving sandy BRIS soil to promote optimum plant growth and yield components of *Arachis hypogaea* is recommended. The optimum watering frequency also help in increasing the moisture level for this poor sandy soil.

According to Lai et al., (2013), growth and activities root and microbes needed soil moisture considered to be a crucial limiting factor.

5.2 Recommendation

Throughout the study, there were some suggestion to further the research on effect green manure on germination and growth of *Arachis hypogaea.* Other than use of green manure, it can be replaced with other organic manure such as compost or animal manure. For example, can apply the other type of green manure for organic matter or fertilizer such as *Leaucena sp*.

Besides, need to identify the nutrient value between types of green manure. It can supply the significant benefit to plant for grow in soil media and rich organic matter. The organic manure is free from harmful chemicals and safe for use as food or commercialized. Thus, the highest the nutrient level in a green manure, it will more effective to solve the problematic soil and can be organic matter that important in a soil. Farming practices have to be change to save the soil and this is where green manure comes in.

REFERENCES

Bala, M., & Nath, K. (2015). Maximization of groundnut (*Arachis hypogaea* L.) yield by nutrient management practices. *Journal of Experimental Biology and Agricultural Sciences*, *3*(3), 241–245.

Beyer, W. H. (1968). *Handbook of table for probability and statistics*. 2.

Bittelli, M. (2011). Measuring soil water content: A review. *Journal of Horttechnology*, *21*(3), 293–300.

Brady, N. C. & Weil, R. R. (2008). The nature and properties of soils. Prentice Hall, 965.

Department of Agriculture. (2010). Production guideline agriculture. *Department of Agriculture*, *Forestry and Fisheries*, 1–24.

Egodawatta, W. C. P., Sangakkara, U. R., Wijesinghe, D. B., & Stamp, P. (2011). Impact of Green Manure on Productivity Patterns of Homegardens and Fields in a tropical dry climate. *Journal of Tropical Agricultural Research*, *22*(2), 172–182.

Entin, J. K., Robock, A., Vinnikov, K. Y., Hollinger, S. E., Liu, S., & Namkhai, A. (1999). Temporal and spatial scales of observed soil moisture variations in the extratropics. *Journal of Geophysical Research*, 1–45.

Foth, H. D. (1990). Fundamentals of soil sciences, 8^{th} edn. Wiley, New York.

Hanafi, M. M., Shahidullah, S. M., Niazuddin, M., Aziz, Z. A., & Mohammud, C. H. (2010). Crop water requirement at different growing stages of pineapple in BRIS soil. *Journal of Food, Agriculture & Environment*, *8*(2), 914–918.

Hartmann, H. T., Kester, D. E., Davies, Jr. F. T., & Geneve, R. L. (2002). *Principles of propagation from seeds*. Plant propagation: Principles and Practices. Michigan California:Pearson.

Hossain, M. D., Hanafi, M. M., Jol, H., & Hazandy, A. H. (2011). Growth , yield and fiber morphology of kenaf (*Hibiscus cannabinus* L .) grown on sandy bris soil as influenced by different levels of carbon. *African Journal of Biotechnology*, *10*(50), 10087–10094.

Hossain, M. D., Hanafi, M. M., Saleh, G., Foroughi, M., Behmaram, R., & Noori, Z. (2012). Growth , photosynthesis and biomass allocation of different kenaf (Hibiscus cannabinus L .) accessions grown on sandy soil. *Australian Journal of Crop Science*, *6*(3), 480–487.

Ishaq, U. M., Armanto, H. M. E., & Arshad, A. M. (2013). Performances of BRIS Soils Genesis and Classification in Terengganu, Malaysia. *Journal of Biology, Agriculture and Healthcare*, *3*(20), 86–93.

Jahan, M. S., Muslianie, I., & Khandaker, M. M. (2014). Effects of soil amendments on BRIS soil health, crop physiology and production. *International Journal of Research and Innovations in Earth Science*, *1*(1), 6–9.

Kelly, R. L. (2011). The role of various elements in plant growth. Retrieved November 28, 2016, from http://www.dpi.nsw.gov.au/land-and-water/soils/improvement/plant-nutrients

Lah, M. K. C., Nordin, M. N., Isa, M. M., Khanif, Y. M., and Jahan, M. S. (2011). Composting increases BRIS soil health and sustains rice production. *ScienceAsia*, *37*(4), 291–295.

Lai, L., Wang, J., Tian, Y., Zhao, X., Jiang, L., Chen, X., Zheng, Y. (2013). Organic Matter and Water Addition Enhance Soil Respiration in an Arid Region. *Journal of Plos One*, *8*(10), 9.

Lim, J. S. (1989). Soil landscape relationship in Kedah: A study of soil genesis and classification. Universiti Putra Malaysia, Serdang, Malaysia.

Miller, C. E., & Turk, L. M. (2008). *Fundamental of soil science.* New Delhi, IN:Biotech Books. 240-283.

Mng'omba, S. A., Toit, E. S. du, & Akinnifesi, F. K. (2007). Germination Characteristics of Tree Seeds : Spotlight on Southern African Tree Species. In *Global Science Books* (pp. 1–8).

N2Africa. (2014). *Better groundnut*. Retrieved from www.N2Africa.org

Neelamegam, R., & Sutha, T. (2015). Original Research Article UV-C Irradiation Effect on Seed Germination , Seedling Growth and Productivity of Groundnut (Arachis hypogaea L .), *4*(8), 430–443.

Nur, A. Y., Alias, A.A., & Wan Zaliha, W. S. (2015). Growth and Water Relations of Roselle Grown on BRIS Soil Under Partial Root Zone Drying. *Malays. Appl. Biol.*, *44*(1), 63–67.

Ntare, B., Diallo, A., Ndjeunga, J., & Waliyar, F. (2008). Groundnut seed production manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 20.

Okello, D. K., Monyo, E., Deom, C. M., Ininda, J., & Oloka, H. K. (2013). *Groundnuts production guide for Uganda : Recommended practices for farmers. National Agricultural Research Organisation, Entebbe*. 1-34.

Okello, D. K., Okori, P., Puppala, N., Bravo-Ureta, B., Deom, C. M., Ininda, J., & Asekenye, C. (2014). *Groundnut seed production manual for Uganda*. 1-42.

Ottman, M. J. (2000). *Seeding Rates for Small Grains in Arizona*. College of Agriculture and Life Sciences. 1-3.

Perez, F. L. (1991). Soil moisture and the distribution of giant Andean rosettes on talus slopes of a desert paramo. *Climate Research*, *1*(2-3), 217–231.

Poomerening, A., & Mustza, A. (2015). Methods of modelling relative growth rate. Forest Ecosystem, 2(1), 5.

Prasad, P. V. V., Kakani, V. G., & Upadhyaya, H. D. (2009). Soils, plant growth and crop production. *Encylopedia of Life Support Systems* (EOLSS), 30.

Prasad, P. V. V, Kakani, V. G., & Upadhyaya, H. D. (2009). Growth and production of groundnut. *UNESCO*, *2*, 1–26.

Ramakrishna, A., Kuniata, L., Rachaputi, R. C. N., & Hughes, M. (2008). *Growing peanuts in Papua New Guinea : a best management practice manual*.

Rosenfeld, B. A., & Rayns, F. (2011). *Sort Out Your Soil*.1-37.

Roslan, I., Shamshuddin, J., Fauziah, C. I., & Anuar, A. R. (2011). Fertility and Suitability of the Spodosols Formed on Sandy Beach Ridges Interspersed with Swales in the Kelantan - Terengganu Plains of Malaysia for Kenaf Production. *Malaysian Journal of Soil Science*, *15*(1), 1–24.

Sangakkara, U. R., Weerasekera, D. N., & Freyer, B. (2008). Green manuring for tropical organic cropping : A comparative analysis. In *16th IFOAM Organic World Congress, Modena, Italy*. (pp. 1–4).

SAS Institute Inc. 1999. SAS Procedure Guide, Version 9.1. Cary. Nc.

Singh, F., & Oswalt, D. L. (1995). *Groundnut Production Practices*. *International Crops Research Institute for the Semi-Arid Tropics Patancheru 502 324, Andhra Pradesh, India*.

Srinivasulu, M., Mohiddin, G. J., Madakka, M., & Rangaswamy, V. (2012). Effect of pesticides on the population of Azospirillum sp . and on ammonification rate in two soils planted to groundnut (*Arachis hypogaea* L .). *Tropical Ecology*, *53*(1), 93–104.

Vakeesan, A., Nishanthan, T., & Mikunthan, G. (2008). Green manures : Nature ' s gift to improve soil fertility. *Leisa Magazine*, 16–17.

Veeramani, P., Subrahmaniyan, K., & Ganesaraja, V. (2012). Organic manure management on groundnut ; A review. *Wudpecker Journal of Agricultural Research*, *1*(7), 238–243.

Zhou, W., Hui, D., & Shen, W. (2014). Effects of Soil Moisture on the Temperature Sensitivity of Soil Heterotrophic Respiration : A Laboratory Incubation Study. *Journal of Plos One*, *9*(3), 1–10.

APPENDICES

APPENDIX A

EXPERIMENTAL LOG

Figure A1: Seed selected with uniform size and health

Figure A2: Seeds was soaked in distilled water for 24 hour

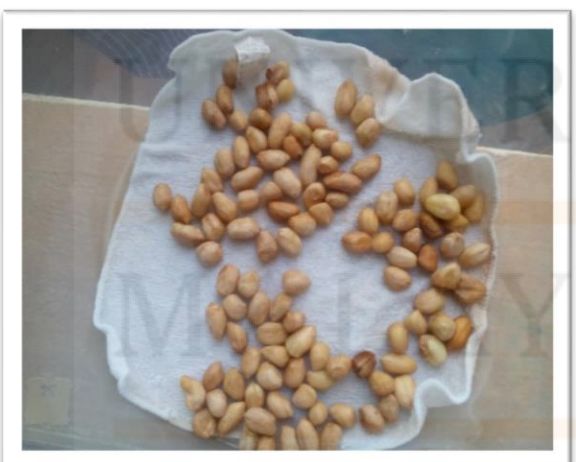


Figure A3: Seeds are placed on wet towel

Figure A4: All of the treatments

Figure A5: Soil moisture checked

Figure A6: Arrangement of polybags

Figure A7: Data for each parameter was collected for every week

Figure A8: Root and Shoot

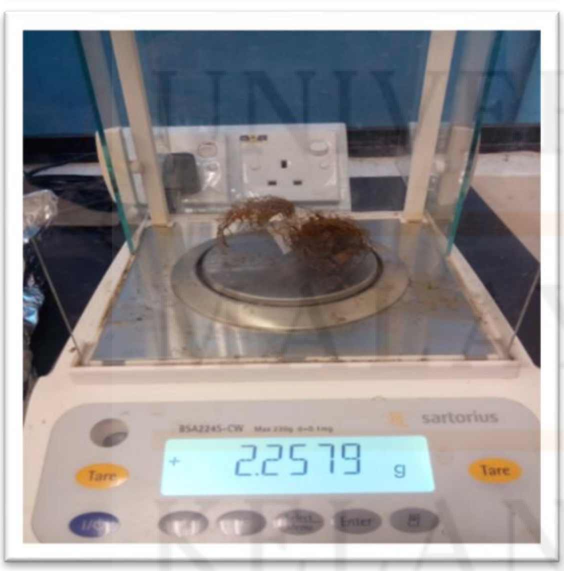


Figure A9: Scales shoot and root

APPENDIX B
RAW DATA

Appendix B1: Means height of *A.hypogaea* (Week 1-Week 8)

Treatments	Means height of *A.hypogaea* (cm)							
	Weeks							
	1	2	3	4	5	6	7	8
T1	1.90	2.75	3.83	4.63	5.18	5.50	5.83	6.75
T2	3.25	4.73	6.05	6.68	7.43	8.05	8.65	9.50
T3	3.00	4.65	5.93	7.00	7.80	9.23	10.08	12.00
T4	3.38	4.13	4.65	5.10	5.50	6.05	6.53	6.75
T5	3.13	4.83	6.00	7.06	7.50	9.40	9.80	11.00
T6	5.00	6.75	8.63	10.58	12.15	14.58	15.03	16.50

Appendix B2: Means of total leaves number (Week 1-Week 8)

Treatments	Means of total leaves number							
	Weeks							
	1	2	3	4	5	6	7	8
T1	9	14	18	21	24	26	30	32
T2	11	15	18	21	23	25	29	33
T3	9	14	20	23	26	28	31	38
T4	10	14	17	21	23	26	28	30
T5	11	17	20	24	30	35	36	40
T6	14	20	23	27	31	34	38	41

Appendix B3: Means of diameter of *A.hypogaea* (Week 1-Week 8)

Treatments	Means of diameter of *A.hypogaea* (mm)							
	Weeks							
	1	2	3	4	5	6	7	8
T1	1.71	2.12	2.37	2.51	2.85	2.94	3.03	3.19
T2	1.63	1.84	2.01	2.16	2.40	2.52	2.67	2.88
T3	2.18	2.38	2.55	2.65	2.92	2.97	3.06	3.16
T4	1.66	2.00	2.39	2.67	2.94	3.01	3.17	3.25
T5	1.57	1.88	2.07	2.36	2.57	2.75	2.83	3.11
T6	2.31	2.61	2.79	2.97	3.09	3.15	3.18	3.54

Appendix B4: Means of dry biomass (Week 1-Week8)

Treatments	Means of dry biomass (g)							
	Days							
	Fresh weight Day 1		Dry weight Day 3		Dry weight Day 4		Dry weight Day 5	
	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
T1	2.89	4.06	0.79	2.18	0.59	1.02	0.59	1.02
T2	4.11	6.22	1.42	3.27	0.67	1.41	0.67	1.41
T3	5.17	6.38	2.64	4.14	1.07	2.10	1.07	2.10
T4	2.69	4.36	1.08	2.42	0.52	1.03	0.52	1.03
T5	6.16	8.19	2.22	4.08	0.75	2.03	0.75	2.03
T6	8.31	10.16	4.97	6.45	1.79	2.91	1.79	2.91

APPENDIX C
STATISTICAL ANALYSIS REPORT
(MINITAB 17)

General Linear Model: H W1 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	7.517	3.759	1.28	0.303
Green manure	1	7.482	7.482	2.54	0.128
Media*Green manure	2	4.901	2.450	0.83	0.451
Error	18	52.985	2.944		
Total	23	72.885			

General Linear Model: H W4 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	61.64	30.818	6.56	0.007
Green manure	1	13.20	13.202	2.81	0.111
Media*Green manure	2	13.13	6.565	1.40	0.273
Error	18	84.53	4.696		
Total	23	172.50			

Comparisons for H W4

Tukey Pairwise Comparisons: Response = H W4, Term = Media

Grouping Information Using the Tukey Method and 95% Confidence

Media	N	Mean	Grouping	
3	8	8.7875	A	
2	8	6.8750	A	B
1	8	4.8625		B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

General Linear Model: H W8 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	225.33	112.667	12.88	0.000
Green manure	1	24.00	24.000	2.74	0.115
Media*Green manure	2	21.00	10.500	1.20	0.324
Error	18	157.50	8.750		
Total	23	427.83			

Comparisons for H W8

Tukey Pairwise Comparisons: Response = H W8, Term = Media

Grouping Information Using the Tukey Method and 95% Confidence

Media	N	Mean	Grouping	
3	8	14.25	A	
2	8	10.25		B
1	8	6.75		B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

General Linear Model: L W1 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	17.33	8.667	0.89	0.429
Green manure	1	24.00	24.000	2.45	0.135
Media*Green manure	2	28.00	14.000	1.43	0.265
Error	18	176.00	9.778		
Total	23	245.33			

General Linear Model: L W4 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	65.33	32.667	1.54	0.241
Green manure	1	32.67	32.667	1.54	0.231
Media*Green manure	2	17.33	8.667	0.41	0.671
Error	18	382.00	21.222		
Total	23	497.33			

General Linear Model: L W8 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	297.33	148.67	4.61	0.024
Green manure	1	42.67	42.67	1.32	0.265
Media*Green manure	2	81.33	40.67	1.26	0.307
Error	18	580.00	32.22		
Total	23	1001.33			

Comparisons for L W8

Tukey Pairwise Comparisons: Response = L W8, Term = Media

Grouping Information Using the Tukey Method and 95% Confidence

Media	N	Mean	Grouping	
3	8	39.5	A	
2	8	36.5	A	B
1	8	31.0		B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

General Linear Model: D W1 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	1.95523	0.977617	7.82	0.004
Green manure	1	0.00060	0.000600	0.00	0.946
Media*Green manure	2	0.04710	0.023550	0.19	0.830
Error	18	2.25080	0.125044		
Total	23	4.25373			

Comparisons for D W1

Tukey Pairwise Comparisons: Response = D W1, Term = Media

Grouping Information Using the Tukey Method and 95% Confidence

Media	N	Mean	Grouping	
3	8	2.2425	A	
1	8	1.6825		B
2	8	1.6000		B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

General Linear Model: D W4 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	1.22763	0.61382	3.00	0.075
Green manure	1	0.30600	0.30600	1.50	0.237
Media*Green manure	2	0.02723	0.01362	0.07	0.936
Error	18	3.67763	0.20431		
Total	23	5.23850			

General Linear Model: D W8 versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	0.49761	0.24880	1.13	0.344
Green manure	1	0.30150	0.30150	1.37	0.256
Media*Green manure	2	0.09776	0.04888	0.22	0.802
Error	18	3.94862	0.21937		
Total	23	4.84550			

General Linear Model: RGR versus Media, Green manure

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	0.000000	0.000000	8.96	0.002
Green manure	1	0.000000	0.000000	2.03	0.172
Media*Green manure	2	0.000000	0.000000	0.46	0.640
Error	18	0.000000	0.000000		
Total	23	0.000000			

Comparisons for RGR

Tukey Pairwise Comparisons: Response = RGR, Term = Media

Grouping Information Using the Tukey Method and 95% Confidence

Media	N	Mean	Grouping	
3	8	0.0008890	A	
2	8	0.0008253	A	B
1	8	0.0007585		B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs