Effect of Organic Manure (Cow Manure) Addition and Soil Moisture Variation on the Growth of Groundnut (*Arachis hypogaea*) on BRIS Soil

by

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DECLARATION

I declare that this thesis entitled 'Effect of organic manure (cow manure) addition and soil moisture variation on the growth of groundnut (*Arachis hypogaea*) on BRIS soil' is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Effects of Organic Matter (Cow Manure) Addition and Soil Moisture Variation on the Growth of Groundnut (*Arachis hypogaea*) on BRIS soil

ABSTRACT

BRIS soil is a problematically abundance sandy soil especially in the coastal area of Peninsular Malaysia. The poor structure, low water retention and insufficient of nutrients content of BRIS soil can be improved through the addition of organic matter. The best and affordable organic matter for soil amendment is cow manure and it has been known as an improving element in agriculture for the sandy soil texture. In this study, three different ratio of soil media and two levels of soil moisture were used to determine the effect on the growth of *Arachis hypogaea*. The three different ratio of BRIS soil and cow manure were 1:0, 1:1, and 1:3. The two level of soil moisture were 30% and 80%. Number of leaves, plant height, diameter of stem, and relative growth rate were calculated. The result was subjected to Analysis of Variance (ANOVA) and the mean obtained was compared in Tukey's Test. Throughout the 8 weeks of study, the best treatment that contributes to the most successful plant growth performance was Media 3 (1 BRIS soil: 3 Cow Manure) with interaction of 80% Soil Moisture. Result showed that Media 3 Soil Moisture 80% had the highest significance effect towards the growth of *A.hypogaea*. For number of leaves, media had the highest significance effect (p=0.000), soil moisture (p=0.017) and interaction of both (p=0.033). For the height of plant, media and soil moisture were significantly higher (p=0.000) and no significance effect for both interaction (p=0.779). For stem diameter, media was highly significant (p=0.000), no significance effect for soil moisture (p=0.517) and interaction of both (p=0.412). These results suggested that crops can be cultivated on BRIS soil after improving the properties of BRIS soil by applying cow manure.

Kesan Penggunaan Bahan Organik (Baja Tinja Lembu) dan Perbezaan Kelembapan Tanah Terhadap Pertumbuhan Pokok Kacang Tanah (*Arachis hypogaea*) di Tanah Beris

ABSTRAK

Tanah Beris merupakan tanah bermasalah yang banyak didapati terutamanya di kawasan pinggiran pantai Semenanjung Malaysia. Struktur tanah yang lemah, kurang pengekakalan air dan kekurangan nutrien pada Tanah Beris boleh diatasi dengan penggunaan bahan organik. Baja tinja lembu merupakan bahan organik yang terbaik dan mampu diperolehi untuk dijadikan sebagai bahan modifikasi tanah berpasir yang telah diketahui pengunaannya sebagai elemen penambahbaikan di dalam bidang agrikultur. Dalam kajian ini, tiga nisbah media tanah dan dua tahap perbezaan kelembapan tanah telah digunakan untuk mengenal pasti kesannya terhadap pertumbuhan *Arachis hypogaea*. Tiga nisbah media yang digunakan adalah campuran tanah beris dan tinja lembu pada kadar 1:0, 1:1 dan 1:3. Dua tahap kelembapan yang digunakan adalah 30% dan 80%. Purata bilangan daun, tinggi pokok, diameter batang dan kadar pertumbuhan telah dikira sepanjang tempoh kajian. Keputusan yang diperolehi di analisis menggunakan ANOVA dan purata telah dibandingkan dengan menggunakan Ujian Tukey. Sepanjang 8 minggu masa ujikaji, perlakuan yang paling menyumbang kepada kejayaan prestasi pertumbuhan pokok ialah Media 3 (1 Tanah Beris:3 baja tinja lembu) dengan interaksi 80% kelembapan tanah. Keputusan menunjukkan Media 3 80% kelembapan tanah memberi kesan signifikansi yang tinggi terhadap pertumbuhan *A.hypogaea*. Untuk bilangan daun, media mempunyai kesan signifikansi yang tinggi (p=0.000), kelembapan tanah (p=0.017) dan interaksi antara kedua-duanya (p=0.033). untuk ketinggian pokok, signifikansi media dan kelembapan tanah adalah yang tertinggi (p=0.000) dan tiada kesan signifikansi terhadap interaksi (p=0.779). Untuk diameter batang pokok, kesan daripada media adalah yang paling tinggi (p=0.000), tiada kesan signifikansi untuk kelembapan tanah (p=0.517) dan interaksi (p=0.412). Keseluruhan keputusan menujukkan tanaman boleh ditanam di tanah Beris selepas penambahbaikan ciri-ciri tanah dengan pengunaan baja tinja lembu.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BRIS	Beach Ridge Interspersed with Swales
CRD	Completely Randomized Design
FC	Field Capacity
g	gram
mm	millimetre
PWP	Permanent Wilting Point
RGR	Relative Growth Rate

LIST OF SYMBOLS

˚C Degree Celsius

% Percentage

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In Kelantan-Terengganu Plains, sandy beach ridges are very common landscape features of coastal zone (Roslan et al., 2011). The plains have sandy texture soil known as BRIS soil. The acronym of BRIS stands for Beach Ridges Interspersed with Swales. BRIS soil is a sandy marine sediments that distributes along the east coast of peninsular Malaysia and the coastal area of Sabah (Hossain et al., 2011).

In peninsular Malaysia, BRIS soil can be found in Kelantan, Terengganu and Pahang. The total cover area of BRIS soil in Kelantan is 17,806.2 hectares, Terengganu with 67,582.61 hectares, Pahang 36,017.17 hectares (Ekhwan et al., 2009) and 40,400 hectares in Sabah. The soil accounts for 1.23% of the total land area in Malaysia (Hanafi et al., 2010) . At present, there are seven types of BRIS soil named Baging, Jambu, Merchang, Rhu Tapai, Rompin, Rudua and Rusila. The types have been classified based on the depth, drainage and serial profile, as recommended by The Department of Agricultural of Malaysia.

BRIS soil is known as one of the problematic soils because it lacks in many physical and chemical properties. It is too sandy, weak soil structured, lack of nutrients and low water retention (Ekhwan et al., 2009). BRIS soil has limited ability to support plant growth since most of the nutrients in the sandy soil are easily leached out (Jahan et al., 2014). Previous study by Chen in 1985 as cited by Hossain et al., (2011) mentioned that BRIS soil contains 82-99% sand particles. The high percentage of sand in BRIS soil will inhibit the plant growth.

In Malaysia, BRIS soils are not suitable for crop production due to the poor fertility (Roslan et al., 2011). Most of the crops planted on BRIS soil did not perform well due to the high surface soil temperature, low water holding capacity, low organic matter content, high infiltration rate and low nutrients availability (Hanafi et al., 2010).

Sandy BRIS soil provides a well-aerated, deep rooting zone, which is ideal for improved the plant growth and production under optimal management of irrigation and nutrients. However, there is still a challenge in managing the soils fertility. For economic reasons, the BRIS soil areas need to be developed into a viable and commercially oriented area.

A study by Jahan et al., (2014) showed that, amended BRIS soil increased the plants physiological parameters which also indicate of increasing BRIS soil health. The study also proves the enhancement of the BRIS soil conditions and plant factors. After modifying BRIS soil's health by using compost or other soil health enhancing materials , crops can be grown on the soil (Jahan et al., 2014).

There are several types of soil amendment that can be mixed with BRIS soil to increase the soil health, water holding capacity and nutrient status (Jahan et al., 2014) for example organic manure and compost. Soil amendment increased relative water content and soil pH while the proper soil management and selection of crops can help in improving the crop production in the BRIS soil area.

1.2 Problem Statement

BRIS soil is a sandy soil of poor nutrients with low water holding capacity. It is not well utilized for crop production due to their inherent poor fertility. There is less data available in terms of crop production on BRIS soil (Jahan et al., 2014). In order to utilize this soil, improvement has to be made by using proper soil management and application of organic manure.

The best solution for BRIS soil improvement can be effective seen with a combination of appropriate soil moisture content and the addition of organic manure as a soil amendment. Organic manure will provide the entire nutrients that are required by plants since BRIS soils are totally lack of nutrients. Soil amendment will increased the soil fertility, nutrient status, relative water retention and maintain the pH of the soil. The yield of groundnut crop grown on improved BRIS will increase substantially. Suitable crops can be cultivated on BRIS soil after improved of its physical and chemical properties of BRIS soil.

1.3 Objectives

The two main objectives to be achieved for this study are as follow;

1. To determine the effects of organic manure addition on the growth and development of *Arachis hypogaea* (groundnut) grown on BRIS soil.
2. To determine the influence of soil moisture variation on the growth and development of *Arachis hypogaea* (groundnut) grown on BRIS soil.

CHAPTER 2

LITERATURE REVIEW

2.1 Groundnut (*Arachis hypogaea*) Crop

Arachis hypogaea or also known as groundnut is an ancient crop originated from South America. Groundnut is an edible plants species. The earlier distribution of groundnut where it was widely grown is in the Central of America and Mexico (Veeramani et al., 2012; Stalker, 1997; Smartt et al., 1994). The genus *Arachis* belongs to the family Fabaceae, which is the legume family.The genus has more than 70 wild species and only *Arachis hypogaea L.* is commonly cultivated and domesticated. The term *arachis* is derived from Greek word, 'arachos' means weed while *hypogaea* means underground chamber that referring to the formation of pods in the soil (Prasad et al., 2009; Rao & Murty,1994; Stalker,1997).

Around 15th century, Asians received groundnuts from Africa and then the agroecosystem of groundnuts widely spread into regions in South East Asia such as China, Indonesia, Vietnam, Thailand, Malaysia and Myanmar. It is believed that Chinese travellers whose introduced the peanuts to Indonesia and Malaysia (Krishna, 2008). In Malaysia, groundnut is known as *kacang china, kacang jawa*, or *kacang tanah.* This crop is now grown throughout the tropical and warm temperate regions of the world.

Groundnut is an annual herb and can reach 30 cm to 50 cm in height. The term groundnut commonly refers to the pods with seed that mature in the underground. The basic precondition for groundnut to grow is the high quality of seed. In general, groundnuts are grown in well drained, light coloured and sandy loams soils.

Groundnut plants are sensitive to salinity and high soil acidity. The pH requirement for soil must be maintain in between 6.2 to 7.8. Saline soils are not suitable because groundnuts have a very low salt tolerance (Krishna, 2008).

The nutrients requirements for groundnuts are lower than most other crops. The crop has responds positively to fertilizer. In general, groundnut requires about 20kg N/ha, 50-80kg P/ha and 30-40kg K/ha. In addition, the growth of groundnut also responds well to the application of organic matter (OM) or farm yard manure (FYM) (Prasad et al., 2009).

Groundnut seed usually takes 5 to 6 days to germinate. After germination, the temperature will determine the growth and production of groundnut. Cool temperature will results in slow growth rate and delay the maturity level. The growing period usually from 120 to 140 days depends on genotype and environment. Groundnut is considered as day-plant and the temperature for optimum growth is 28°C to 30°C. Generally, they grow best in light textured sandy loam soils with a rainfall of 500 mm to 1000 mm (Prasad et al., 2009).

Nowadays, the interest in growing groundnut has increased since it is an important oil seed crop of the world (Krishna, 2008). It serves community around the world as one of the popular oil and protein source that being used in over 100 countries of the world. Groundnuts are used in various forms, which include groundnut oil, roasted and salted groundnut or as paste popularly known as peanut butter. Groundnut oil is the cheapest and most extensively used vegetables oil mainly for cooking.

Every part of the crop has its own use. For example the dry pericarp of the mature pods is used as a soil conditioner or it being processed as substitute for hardboard or used for composting with the aid of lignin bacteria. The leaves are used in certain parts of West Africa as a vegetable in soups (Prasad et al., 2009).

2.1.1 Morphology of groundnut

Groundnut plant is a self-pollinating and an annual herbaceous legume. Natural cross pollination of groundnut occurs at rates of less than 1% to greater than 6% with the help of pollinating agents such as flowers and the action of bees (Ntare et al., 2008).

Groundnut seed is made up of an outer testa (skin), two cotyledons (seed leaves) and an embryo. The embryo is not totally protected by the cotyledons and can easily be damaged. The two cotyledons are; stem axis and leaf primordia and hypocotyls and primary root. Hypocotyl will push the seed to the soil surface during germination stage and its length is determined by planting depth (Hughes et al., 2008). It stops elongating as soon as the light strikes the emerging cotyledon. This makes the groundnut to stay intermediate between the soil surface and the ground. The cotyledons will emerge from the soil around 6 to14 days after planting.

Leaves of groundnut plant are alternate and pinnate with two pairs of leaflets per leaf. The flowers of groundnut crops are self-pollinated in the sunrise and then will wither within five to six hours (Prasad et al., 2009). Within four week of fertilization, the carpophore or a unique floral structure is formed. The maximum number of flower production occurs during six to ten weeks after planting. One to several flowers may be present at each node and the flowers are usually abundant at the lower nodes.

Once the small yellow flowers are self-pollinated, the fertilized ovary elongates into a peg, which grows downward and penetrates into the soil. Groundnuts will develop underground at the ends of the pegs. The peanut seed is referred to as a kernel and the outer shell is called a pod. Rapid growth of groundnut crop is only being observed between 40 to 100 days after emergence (Prasad et al., 2009).

2.1.2 Maintenance of groundnut

At the early stage of sowing development usually 3 to 6 weeks after sowing, groundnut cannot compete with weeds. To reduce competition, weeds need to be removed from the planting area. Groundnuts crop should be weeded within the first 45 days (Ntare et al., 2008). At this stage, weeds can be controlled by hand-pulling. The most effective way is to apply herbicide and followed by mechanical or hand weeding once or twice to keep the crop free of weeds (Ajeigbe et al., 2014).

A reasonable level of organic matter must be maintained at the place where groundnuts are grown. Ajeigbe et al., (2014) mentioned that, groundnut has been reported to respond better to residual fertilization compared to direct fertilization. Groundnuts can be cultivated with a balanced N-P-K fertilizer. Recommended NPK fertilizer for groundnut crop is: 5kg of N, 10 kg of P_2O_5 and 20kg of K_20. Calcium must be added to the acidic soils to correct the pH and improve the quality of seeds. Lack of calcium levels can lead to highly improper filled pods.

2.2 Seed germination and growth performances

Seeds contain everything necessary for the growth and development of a new plant. Seed is the basic input and most of the plant life cycle starts with the seed. In order to complete the life cycle, seed must germinate, survive, being matured and produce new seeds (Mordecai, 2012). There are many factors that contribute to the survival and germination of the seeds. Favourable environmental condition is a must for successful seed germination. Other factors for germination include moisture, air, optimal temperature, humidity, and nutrient supply.

Growth of a plant is the increment in dry mass, volume or length. Plant growth analysis is considered to be a parameters approach to study of plant growth and its productivity (Ozalkan et al., 2010). It is an explanatory and integrative approach to interpreting plant form and its function. Parameters for plant growth analysis can be determined based on its measurement of height, dry biomass weight, the leaves area, diameter of stems and, number of leaves.

2.3 Soil texture

Soil texture is an important soil characteristic that influences water infiltration rates. The textural class of a soil is determined by the percentage of sand, silt, and clay. Soils can be classified as one of four major textural classes: sands; silts; loams; and clays.

Texture generally refers to the size of the particles that make up the soil. The terms sand, silt, and clay refer to relative sizes of the soil particles. Sand, being the larger size of particles, feels gritty. Clay, being the smaller size of particles, feels sticky. It takes 12,000 clay particles lined up to measure one inch. Silt, being moderate in size, has a smooth or floury texture. The combined portions of sand, silt, and clay in a soil determine its textural classification. Sand particles range in size from 0.05–2.0 mm, silt ranges from 0.002–0.05 mm, and the clay fraction is made up of particles less than 0.002 mm in diameter. Gravel or rocks greater than 2 mm in diameter are not considered when determining texture (Pagliai, 2007).

Once the sand, silt, and clay percentages of a soil are known, the textural class can be read from the Soil Textural Triangle (Young & Young, 2002) . For example, a soil with 40% sand, 40% silt and 20% clay would be classified as a loam. Texture should not be confused with structure, which refers to how soil particles are aggregated together. It is possible to improve soil structure via best management practices such as addition of organic manure.

Soil textures classifications are typically named for the primary constituent particle size or a combination of the most abundant particles sizes, e.g. "sandy clay" or "silt clay". The term "loam" is used to describe a roughly equal concentration of sand, silt, and clay, brings to the naming of even more classifications, e.g. "clay loam" or "silt loam" (Young & Young, 2002).

Soil texture determines the rate at which water drains through a saturated soil; water moves more freely through sandy soils than it does through clayey soils. Soil texture also influences how much water is available to the plant; clay soils have a greater water holding capacity than sandy soils. In addition, well drained soils typically have good soil aeration meaning that the soil contains air that is similar to atmospheric air, which is conducive to healthy root growth, and thus a healthy crop (Moore, 2001).

Soils also differ in their susceptibility to erosion based on texture; a soil with a high percentage of silt and clay particles has a greater risk of erosion than a sandy soil under the same conditions. Differences in soil texture also impacts organic matter levels; organic matter breaks down faster in sandy soils than in fine-textured soils, given similar environmental conditions, tillage and fertility management, because of a higher amount of oxygen available for decomposition in the light-textured sandy soils.

2.4 Soil and water relationship

Plant growth usually depends on the present of soil and water. Soil provides mechanical support and nutrient for the plants. While, water is an essential element for plant life processes. The role of soil moisture content is important in biophysical process such as seed germination, plant growth and plant nutrition (Bittelli, 2011). Soil moisture content will affect the germination of seed and decomposition of organic matter.

Soils hold different amounts of water depending on their texture and structure. The maximum limit of water holding capacity is referred to the term 'field capacity' (FC) while the minimum limit is the 'permanent wilting point' (PWP).

FC occurs when a saturated soil is allowed to freely drain under the force of gravity and if there is no evaporation loss, moisture content of the soil will reach the equilibrium level after a period of time (Osman, 2013). The amount of water holding capacity then is simply called field capacity. The soil profile that is full of water is said to be at 100% moisture content. Tension is a measurement how tightly the soil particles hold onto water molecules in the soil.

As soon as the water content decreases to a certain level at a lower point until the plants cannot extract water from the soil, the tension become lower. This is the level of moisture content at which plant leaves permanently wilt and do not reach again their turgidity even after they are watered again. The percentage of soil moisture at this point is known as permanent wilting point (Osman, 2013). The PWP occurs at different moisture levels depending on the plant and soil type.

Available water capacity (AWC) is the range of available water that can be stored in soil and be available for growing crops (Kirkham, 2014). It is defined as the water held between FC and the water content at PWP.

As reported by Martin (2009), knowledge about available soil water and soil texture can influence the decision-making process, such as determining what crops to plant and the watering schedule. The irrigation scheduling determines when and how much water needs to be added to a crop's root zone in order to promote optimum crop production.

2.5 Soil fertility

Soil fertility generally refers to the ability of soil to support the plant growth. It is a complex quality of soils that is closest to plant nutrient management. Fertile soil will provide plant habitat with high quality and constant yield production. It also contains necessary nutrients for basic plant nutrition including nitrogen, phosphorus and potassium. It often has large amount of topsoil and variety of microorganisms that sustain the plant growth (Tinsley & Darbyshire, 2012). The organic matter in fertile soils improves soil structure and moisture retention.

Managing soil fertility in crop field can be challenging. Soil management requires knowledge of crop nutrient requirements, soil nutrient levels and the types of fertilizers that will be used.

2.6 Features of organic manure

Plants need a well-balanced diet, for better growth and yield. Manures are the substances that provide nutrients for proper growth of plants. Manure is anything that has been added to the soil to increase its fertility and enhancing for plant growth (Jennifer et al., 2012). The word manure came from Middle English "*manuren*" meaning "to cultivate land," and initially from French "*main-oeuvre*" means "hand work" alluding to the work which involved manuring land. Manure is not just the urine and faeces from livestock, but also the bedding, runoff, spilled feed, and anything else mixed with it. Manures contribute to the fertility of the soil due to addition of organic matter and nutrients, such as nitrogen that is trapped by bacteria in the soil (Zubair et al., 2012).

Manures can be divide into two classes; organic and inorganic manure. Organic manures are derived from decaying material of plant or animal origin. While inorganic manures that also known as fertilizer are derived from chemical processes (Jennifer et al., 2012).

Organic manure can be a good fertilizer because it consists of nitrogen, phosphorus, potassium and other important nutrients. It also helps in the need of organic matter to the soil which can improve the soil structure, soil moisture holding capacity and infiltration of water into the soil. Application of organic manure can improve the pH of the soil and its chemical properties (Madukwe et al., 2008).

CHAPTER 3

MATERIALS AND METHODS

The experiment was carried out at Agropark, Universiti Malaysia Kelantan (UMK) Jeli Campus. The seeds of groundnut were bought from Federal Agricultural Marketing Authority (FAMA). Seeds that are healthy and free from damage were used for the experiment and soil media that was used, BRIS soil was obtained from Bachok, Kelantan.

3.1 Experimental setup

A 3x2 factorial experiment was carried out. The two independent variables for this experiment are; germination media and soil moisture. The germination media treatment involved with three levels while the soil moisture treatment involved with two levels of soil moisture. Treatments for germination media consisted of three different ratio of BRIS soil and cow manure. While for percentage (%) of the moisture levels consisted of two different moisture levels of the soil field capacity. The involved treatments were as shown in the Table 3.1.

Table 3.1: Treatments for the experiment

No.	Treatments	Descriptions
1.	Growth media	BRIS soil : Cow manure (1:0)
		BRIS soil : Cow manure (1:1)
		BRIS soil : Cow manure (1:3)
2.	Soil moisture levels (%)	30 % moisture of field capacity
		80 % moisture of field capacity

The BRIS soil was sieved to separate the unwanted particles from the soils. Then, the soil was undergoing treatment with the soil amendment, the cow manure. BRIS soil was mixed with the cow manure according to the stated ratio of the germination media. Different treatments that were applied are; Treatment 1 (T1), BRIS soil: cow manure (1:0), Treatment 2 (T2), BRIS soil: cow manure (1:1) and Treatment 3 (T3), BRIS soil: cow manure (1:3).

Figure 3.1: Preparation of soil media

The germination media will then filled in the polybags with the volume of 1000cm^3 for each polybag. Each treatment included four replications respectively according to the ratio. The total number of polybags that used was 24. Polybags were placed at the distance of 15cm between each other. These polybags have two different soil moisture levels, 12 polybags for 30% of field capacity and another 12 polybags for 80% of field capacity. Experiment was arranged in Completely Randomized Design (CRD). The polybags were labelled according to the Table 3.2.

Table 3.2: Layout design for Completely Randomized Design (CRD)

Treatments	Soil moisture level	Labelling
Treatment 1 (T1)	30 % of field capacity	A_{01}, A_{02}, A_{03}, A_{04}
BRIS soil : Cow manure (1:0)	80 % of field capacity	B_{05}, B_{06}, B_{07}, B_{08}
Treatment 2 (T2)	30 % of field capacity	A_{09}, A_{10}, A_{11}, A_{12}
BRIS soil : Cow manure (1:1)	80 % of field capacity	B_{13}, B_{14}, B_{15}, B_{16}
Treatment 3 (T3)	30 % of field capacity	A_{17}, A_{18}, A_{19}, A_{20}
BRIS soil : Cow manure (1:3)	80 % of field capacity	B_{21}, B_{22}, B_{23}, B_{24}

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 was considered as the starting point. The last two digit numbers represent 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 3.1, the two last digits that appear with a similar number as labelled at the polybags were chosen. The selection was continued until all the samples were included in the field layout arrangement.

	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 3.2: Tables of Random Number (Beyer, 1968)

The result for the selection from the Tables of Random Number is shown as in the Figure 3.2. It was used as the field layout throughout the period of the experiment at Agropark UMK Jeli.

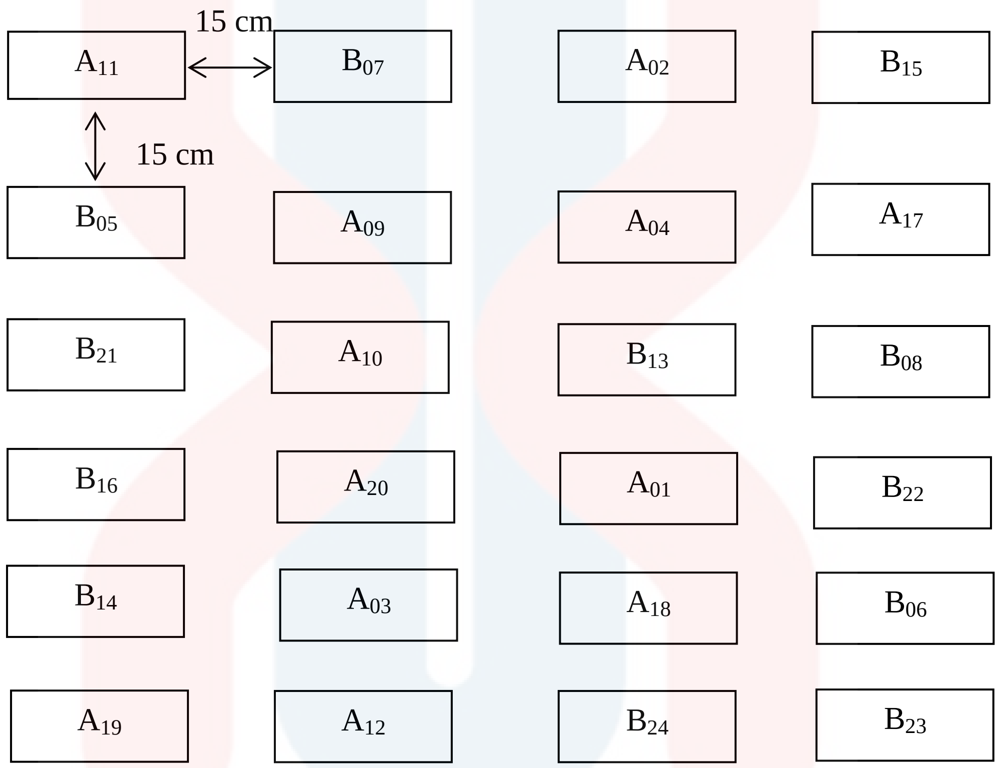

Figure 3.3: Field layout for experimental design

3.2 Determination of watering schedule

The germination media in all the polybags was watered until it reached the field capacity. Then, they was left until no water is drain out from the polybags. At this point, the germination media is said to be at the maximum level of the field capacity.

Moisture meter was used to determine the soil moisture levels in each polybags. The moisture level was measured repeatedly until it reached the moisture level, 30 % and 80% of the field capacity. The time taken for the soil moisture content to reach the specified value (30% and 80%) was recorded and they were used as the time interval for the groundnut plant watering schedule.

3.3 Soil texture test

Soil texture was measured by using BRIS soil will be spread on a newspaper to remove all the rocks, roots and unwanted particles. Soil was filled in a thin and tall jar and water was added until the jar is three-quarters full. To breaks apart the soil aggregates and separate the soil into individual mineral particles, the jar was hardly shaken for 10 to 15 minutes.

It was left undisturbed for 2 to 3 days. The soil particles will settle out according to their size. When the water clears, the depth of the sand, silt and clay level was marked on the measuring cylinder.

The thickness and percentage of the sand, silt, and clay layers was measured by using a ruler. The textural class was determined by using the soil triangle.

3.4 Seed sowing process

The groundnut seeds were soaked in distilled water for 24 hours to soften the seed coat. The healthy soaked seeds that germinated were then transferred into the polybags. They were sown at the depth of 4-5 cm (Sulfab, 2013). Four groundnut seeds were put in each polybag. The total number of seeds used is 96. After two weeks of sowing process, only one groundnut seed in each polybags will be allowed to germinate and develop into plant.

Watering was carried out based on the watering schedule of the soil moisture treatments. Weeding and pesticides application were made when necessary. The experiment will was terminated exactly after two months of planting period.

3.5 Growth performance analysis

Observation and measurement of groundnut plants heights was made weekly. Height was measured from soil base to the plant tip by using steel ruler (in cm). For all the seedlings per treatment, the stem diameter was measured by using digital Vernier calliper calibrated in millimetre (mm) (Omokhua et al., 2011). Number of leaves was counted visually every week. The counting only involves intact leaf on the plant including the tips of new leaves that just beginning to emerge.

3.5.1 Percentage of seed germination

The calculation of the percentage of germination will be made at the beginning of experiment. Seeds were allowed to germinate on wet towel method for 10 days. After completed the 10 days, all the germinated seeds were counted. A seed is considered germinate as soon as the plumule is above the soil media. The percentage of germination was calculated by using the following formula as shown in the Equation 3.1.

$$10\ days\ germination\ (\%) = \frac{no\ of\ germinated\ seeds}{total\ number\ of\ seeds} x100\ \% \quad \text{(eq. 3.1)}$$

3.5.2 Dry biomass weight

At the end of the experiment, the seedlings of groundnut plants were harvested. They were removed from the soil and any soil particles attached were washed off with water. Then, the wet weights of the plants were recorded. The clean plant was dried in an oven with low heat (~70°C) for a night. After that, the plant was cooled down in a dry environment and once the plant was cooled, it was weighed on a digital weighing balance. The weight was recorded every day until the biomass reached its constant weight. The dry biomass weight was calculated by using formula as shown in the Equation 3.2.

$$Dry\ biomass\ (g) = \ wet\ weight\ (g) - dry\ constant\ weight\ (g) \qquad \text{(eq. 3.2)}$$

3.5.3 Relative Growth Rate

The average rate of growth of the seedling was calculated by using Relative Growth Rate (RGR) formula (Zheng et al., 2014) as shown in the Equation 3.3.

$$RGR = \frac{(\ln W_2 - \ln W_1)}{(t_2 - t_1)} \qquad \text{(eq. 3.3)}$$

Where;

ln = natural logarithm

t_1 = time of experiment starts (in day)

t_2 = time of experiment end (in day)

W_1 = initial dry weight of plant at t_1 (in grams)

W_2 = initial dry weight of plant at t_2 (in grams)

3.6 Carbon content in the soil media

The soil media sample from Treatment 1, 2 and 3 were taken out for the carbon content test. Approximately 20g of soil from Treatment 1 was placed in a crucible then it was heated in maffle furnace for 3 hours with the temperature of 400 °C (Omokhua et al., 2011). The weights of the soil were recorded before and after the heating process. The percentage of carbon contain in the soil was calculated by using the formula as shown in the Equation 3.4. Test was repeated with the soil sample from Treatment 2 and 3.

$$Carbon\ content\ \% = [(Burned\ soil + crucible\ weight) - (Dry\ soil + crucible\ weight)/(burned\ soil + crucible\ weight]x100\% \quad \text{(eq. 3.4)}$$

3.7 Statistical analysis

All the data collected (Appendix B) were subjected to Analysis of Variance (ANOVA) using Minitab 17 statistical package software (Minitab Inc USA). Then, the post hoc test, Tukey's Test was followed after the analysis to find the means that are significantly different to each other. The results were considered significant at 0.05 probability level.

CHAPTER 4

RESULTS AND DISCUSSION

To facilitate discussion, six treatments in the study abbreviated as in Table 4.1.

Table 4.1: Treatments and abbreviation in the study

No	Treatment	Abbreviation
1	Media 1xSoil Moisture 30%	M1SM30
2	Media 2xSoil Moisture 30%	M2SM30
3	Media 3xSoil Moisture 30%	M3SM30
4	Media 1xSoil Moisture 80%	M1SM80
5	Media 2xSoil Moisture 80%	M2SM80
6	Media 3xSoil Moisture 80%	M3SM80

4.1 Soil texture test

BRIS soil that was used throughout the period is as shown in Figure 4.1 of the experiment is clearly seen as the sandy soil with really fine soil particles.

Figure 4.1: BRIS soil

The result obtained for the soil texture test as shown in Table 4.2 was compared to the Soil Texture Triangle (USDA, 1987) and it was classified mainly as sand.

Table 4.2: Soil texture test

	Depth of soil (cm)	Percentage (%)
Clay	0.084	$\frac{0.08}{3.0} \times 100\% = 13.33$
Silt	0.144	$\frac{0.14}{3.0} \times 100\% = 16.67$
Sand	2.772	$\frac{2.77}{3.0} \times 100\% = 70.0$
Total	3.0	100

4.2 Carbon content in soil media

The soil media that was used as growing media for groundnut plants were tested to determine its carbon content. For Media 1 (1 BRIS soil : 0 Cow manure), the total carbon content recorded is 12.24%. It has the lowest percentage of carbon since there was no addition of cow manure in the soil media 1. The only amount of carbon exists in the Media 1 is originally from the soil. For Media 2 (1 BRIS soil : 1 Cow manure) the total carbon content is 52.85%. While, for Media 3 (1 BRIS soil : 3 Cow manure) the total carbon content is 82.07%.

Increasing in manure quantity resulting in an increased of percentage of carbon content. The highest carbon content was recorded the highest in Media 3 as shows in Table 4.3.

Table 4.3: Total of soil carbon content in media

Soil sample	Crucible + dry sample soil A (g)	Crucible + burned soil B (g)	Carbon content (%) $(\frac{A-B}{A})\ x100\%$
Media 1	20.35	17.86	12.24
Media 2	20.17	9.51	52.85
Media 3	20.92	3.75	82.07

4.3 The growth performance analysis

The objective in this study was to determine the effects of soil media mixed with cow manure and soil moisture variation on the growth performances of groundnut. Observation on the growth of the groundnut has been made weekly and all the three parameters discussed below shows the increasing and decreasing patterns in the number of leaves, height and diameter of plants. Overall growth result shows the plants in M3SM80 were the most successful in this experiment in term of number of leaves, height weight and diameter of stem. The in M3SM80 was gave the earliest flowering among the other treatments. The earlier flowering at Week 4 was possibly due to high amount of the nutrient potassium, K in the cow manure for the treatment (Mugwira & Murwira, 1997).

4.3.1 Effects on the number of leaves

Through the 8 weeks observation period, the results show that the number of leaves for Media 3 with the interaction of 80% Soil Moisture had the highest mean value among all the treatments. Figure 4.2 shows the effects of soil amendment with cow manure and two levels of soil moisture content on the number of leaves for the total of six treatments.

Mean for the total number of leaves recorded shows the increasing in trend during the first week until the end of Week 8. The rapid increase of number of leaves can be seen in M3SM80. In the Week 8, the highest mean for leaves number was recorded was 143 for M3SM80. While, the lowest mean number of leaves recorded was 33 for M1SM30.

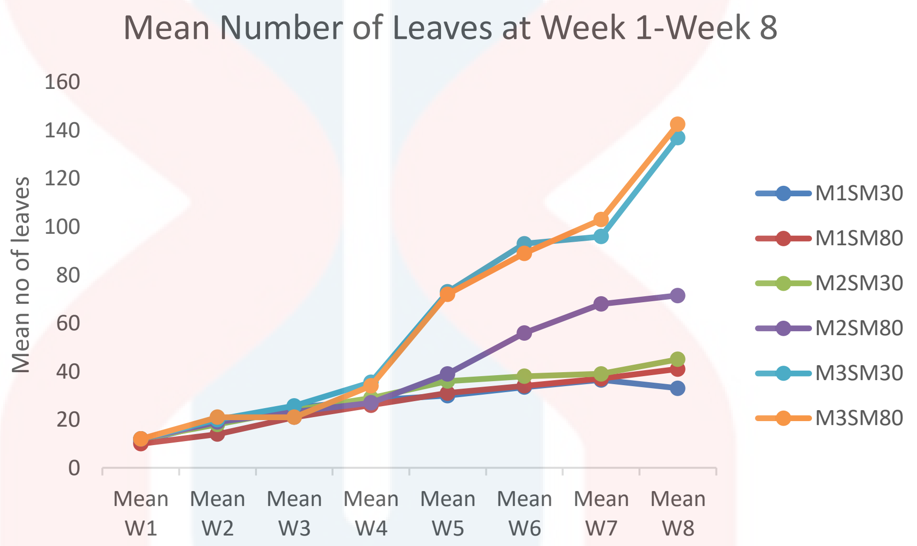

Figure 4.2(a): Mean number of leaves at Week 1-Week 8

Increasing the levels of organic manure in soil improved relatively the number of leaves. This has been consequences effects of application of cow manure (Pierre et al., 2015). High rates of cow manure as soil amendment increased the leaves number as it contain amount of nutrients especially Nitrogen (N) which promotes leafy structure of a plant (Adeoya et al., 2011). The optimum level of soil moisture hold the water retention (Lipsius, 2002). The decreasing of leaves can be seen at M1SM30 at Week 8 as it contains less organic matter to support the nutrients supply to the plants. Low organic matter causing N deficiency symptoms on the plants of the older leaves hence plants loss their leaves to regenerate new leaves (Kelly, 2011). This is the possibility happened in M1SM30 that leads to decreasing of number of leaves at Week 8.

Week 1, 4 and 8 were chosen to discuss the growth phase of *Arachis hypogaea*. Week 1 indicates the earlier growth phase, Week 4 as the intermediate phase while Week 8 was the end phase of the growth of groundnut in the study.

ANOVA for leaves number in Table 4.4 show that soil media had the significant effects for Week1 (p=0.040), Week 4 (p=0.013) and effect of soil media become highly significant on number of leaves at Week 8 (p=0.00).

As for the soil moisture, only at Week 8 the significant effect with the p-value=0.017 was observed. Week 1 (p=0.521) and Week 4 (p=0.993) showed no significant effect for the leaves number.

The interaction between media and soil moisture showed no significant effect (p=0.658, p=0.993) at Week 1 and Week 4 but highly significant (p=0.033) at Week 8. As the time increase, there was a significance effect towards the number of leaves.

Table 4.4: ANOVA for Number of Leaves at Week 1, Week 4 and Week 8

	Week 1		Week 4		Week 8	
Source	F-value	P-Value	F-value	P-value	F-value	P-Value
Media	3.86	0.040*	5.58	0.013*	214.56	0.000***
Soil Moisture	0.43	0.521n.s	0.79	0.386n.s	6.95	0.017*
Media x Soil Moisture	0.43	0.658n.s	0.01	0.993n.s	4.13	0.033*

* Significance difference (p<0.05), n.s non-significance difference (p>0.05)

Based on ANOVA result, Tukey's Test was performed to know the treatment that gave the best effect throughout the study. Figure 4.2(b) showed illustrated graph of the Tukey's Test result of the effect of soil media on number of leaves on Week 8. All the media gave a significance effects on the number of leaves of *A.*hypogaea. Media 3 had the highest mean number compared to Media 1 and Media 2 at Week 8.

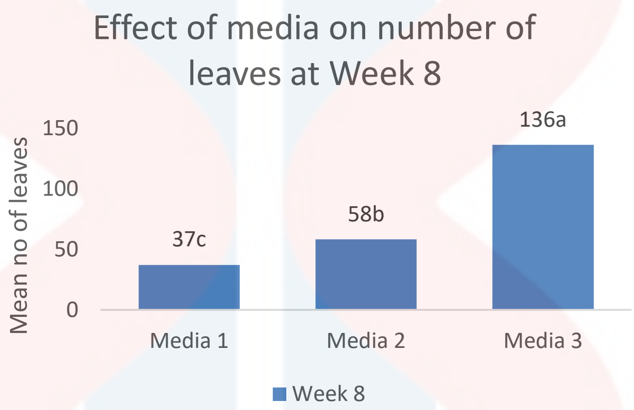

Figure 4.2(b): Effect of media on number of leaves at Week 8

Mean comparison from the Tukey's Test at Week 8 for the interaction between media and soil moisture is shown in Figure 4.2(c). M3SM80 had the highest mean compare to the other interactions. The treatment can be arranged in order of M1SM30>M1SM80>M2SM30>M2SM80>M3SM30>M3SM80

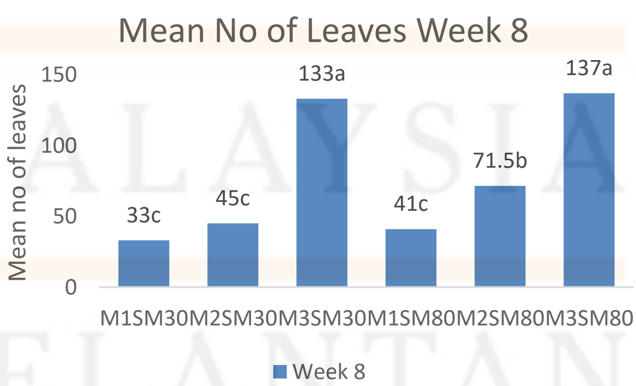

Figure 4.2(c): Effect of treatment on number of leaves at Week 8

Figure 4.2(d) show the mean comparison from Tukey's Test at Week 8. From ANOVA result, only Week 8 showed the significant effect of soil moisture in leaves number. Soil Moisture 80% had the highest mean compared to Soil Moisture 30%. This showed that Soil Moisture 80% gave the best effect for the number of leaves in this study.

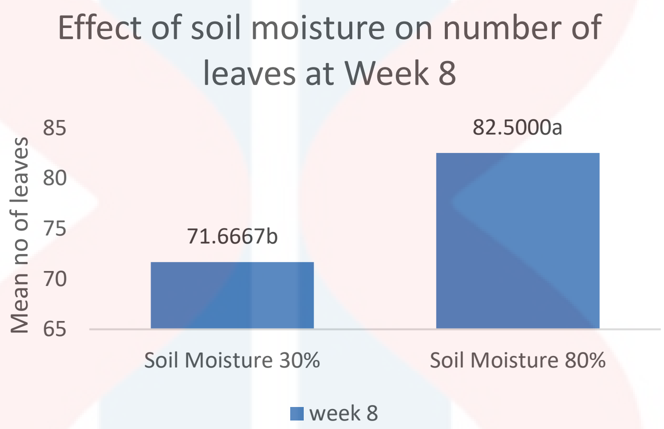

Figure 4.2(d): Effect of soil moisture on number of leaves at Week 8

4.3.2 Effects on the height of plant

The results show that the number of leaves for M3SM80 had the highest value of all the treatment. The height value recorded was 32 cm for M3SM80. Figure 4.3(a) shows the mean for the height of plant through the 8 weeks observation period.

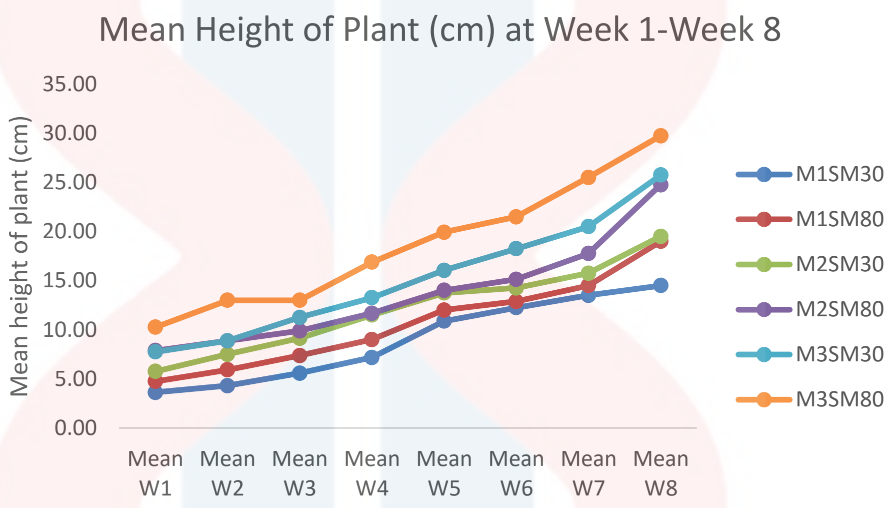

Figure 4.3(a): Mean height of plant (cm) at Week 1-Week 8

From this experiment, it was generally observed that addition of cow manure increased the height of plant varied with its organic manure composition and according to the mixing ratio (Adebayo et al., 2010). M1SM30 that contained no organic manure had the least mean for the height of plant. While the highest mean recorded in Treatment 3 contain the highest amount of cow manure among the other treatments.

The increment of cow manure which had influenced in mobilizing the nutrients uptakes mainly due to the improvement of soil properties (Pierre et al., 2015). The nutrients Nitrogen, N from organic matter stimulate the leafy structure of a plant and continuously promotes the plant size and height. Optimum rate supplied amount of N makes a responsive growth performance of plants (Chandra, 2005). In this study, probably the highest height is a result of optimum available of N from the application of cow manure.

Week 1, 4 and 8 were chosen to discuss the growth phase of *Arachis hypogaea*. Week 1 indicates the earlier growth phase, Week 4 as the intermediate phase while Week 8 was the end phase of the growth of groundnut in the study.

ANOVA for leaves number in Table 4.5 shows that the media is highly significance (p=0.000) at Week 1. The soil moisture also showed significant effect towards the plant height (p=0.000) and there is no significance difference between the interaction of Media and Soil Moisture (p=0.308) at Week 1.

ANOVA result showed that both media and soil moisture were significantly affect the height of plant during the study at Week 4 (p=0.002) and at Week 8 (p=0.000).

At 5% probability level, there was no significant effect of the interaction between media and soil moisture on the height of *A.hypogaea* at Week 4 and Week 8 (p=0.405, p=0.779).

Table 4.5: ANOVA for Height of Plant at Week 1, Week 4 and Week 8

	Week 1		Week 4		Week 8	
Source	F-value	P-Value	F-value	P-value	F-value	P-Value
Media	57.84	0.000***	60.45	0.000***	77.45	0.000***
Soil Moisture	27.45	0.000***	13.11	0.002*	40.33	0.000***
Media x Soil Moisture	1.26	0.308n.s	3.70	0.405n.s	0.25	0.779n.s

* Significance difference (p<0.05), n.s non-significance difference (p>0.05)

From ANOVA result, Tukey's Test was performed for all the factors that gave significant effect. In Table 4.5(d), the mean comparison in the test was illustrated to show the effect of soil media on number of leaves. All the media gave a significance effects on the number of leaves of *A.hypogaea*. This showed the growth performance of the height of groundnut plant at three different stages. At Week 1, 4 and 8, mean for Media 3 is significantly higher compared to Media 1 and Media 2. From the graph, it clearly showed that Media 3 gave the best performance started from the early phase until the end of the study.

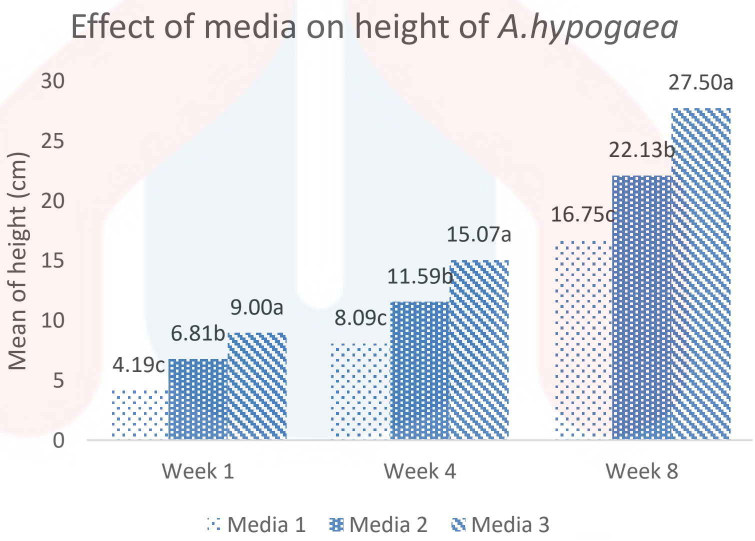

Figure 4.3(b): Effect of media on height of *A.hypogaea*

According to Figure 4.3(c), Week 1, 4 and 8 showed that mean form the Tukey's Test mean comparison for number of leaves at Soil Moisture 80% and Soil Moisture 30%. Both of the moisture level gave effect for the height of *A.hypogaea*. However illustrated graph below showed that the best moisture level for the plant is 80% followed by 30% of soil moisture for every phase of the growth performance.

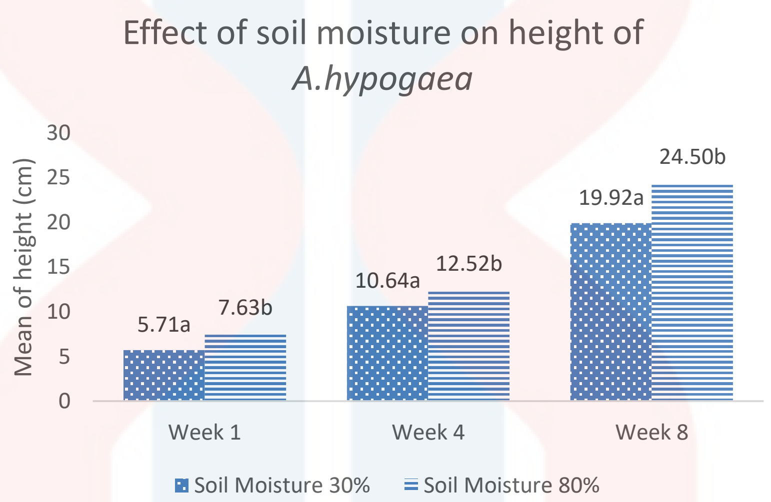

Figure 4.3(c): Effect of soil moisture on height of *A.hypogaea*

4.3.3 Effects on diameter of stem

Results shown in Table 4.3 shows that the number of leaves for Treatment had the highest value of all the treatment. The increasing in trends for the mean value of the diameter of stem can be seen in Figure 4.3. Treatment 3 recorded biggest stem diameter value of 4.97mm for the eighth week while 2.81mm from Treatment 1 was the smallest diameter of stem in the same week.

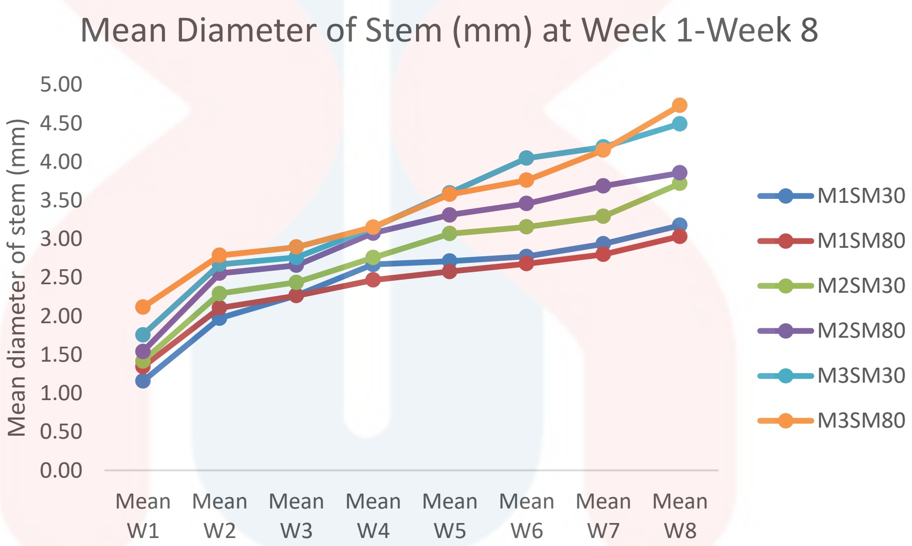

Figure 4.4(a): Mean diameter of stem (mm) at Week 1-Week 8

Application of cow manure to the sandy soil gives response to the diameter of stem and vegetative plant growth (Senjobi et al., 2013). The higher plant growth as a result of organic matter amendment is associated with the fact that the materials release considerable amount of nutrients especially Nitrogen (N) for plant use (Adebayo et al., 2010).

Week 1, 4 and 8 were chosen to discuss the growth phase of *Arachis hypogaea*. Week 1 indicates the earlier growth phase, Week 4 as the intermediate phase while Week 8 was the end phase of the growth of groundnut in the study.

From Table 4.6, media and soil moisture at Week 1 had significant effect on the diameter of stem. Media is highly significant (p=0.000) and no significant effect of soil moisture on the diameter of stem (p=0.045). Also, there was no significant effect observed between the interaction of media and soil moisture (p=0.647).

While at Week 4, the interaction of media and soil moisture showed no significant effect on diameter of stem (p=0.523). The soil moisture gave no significant effect (p=0.413). Only the media had the highly significant effect (p=0.000) towards the diameter of stem of *A.hypogaea*.

At week 8, there was no significant effect showed between the interaction of media and soil moisture (p=0.412). The soil moisture had no significance (p=0.517). Highly significant effect (p=0.000) was only observed for the media towards the effect on diameter of stem.

Table 4.6: ANOVA for Diameter of Stem at Week 1, Week 4 and Week 8

	Week 1		Week 4		Week 8	
Source	F-value	P-Value	F-value	P-value	F-value	P-Value
Media	15.01	0.000*	48.30	0.000***	54.05	0.000***
Soil Moisture	4.62	0.045*	0.70	0.413n.s	0.44	0.517n.s
Media x Soil Moisture	0.45	0.647n.s	9.62	0.523n.s	0.93	0.412n.s

* Significance difference (p<0.05), n.s non-significance difference (p>0.05)

Table 4.4(b) shows the mean comparison from the performed Tukey's Test. During Week 1, 4 and 8, media gave effect towards the growing diameter of the *A.hypogaea*. Growth performance of the three phases showed that Media 3 had the best effect at Week 1, Week 4 and Week 8 followed by Media 2 and Media 1. The mean for Media 3 is significantly higher compared to Media 1 and Media 2. Media 1 had the lowest mean compared to the other two media. The low effect of media towards stem diameter can be arranged starting from Media 1>Media 2>Media 3.

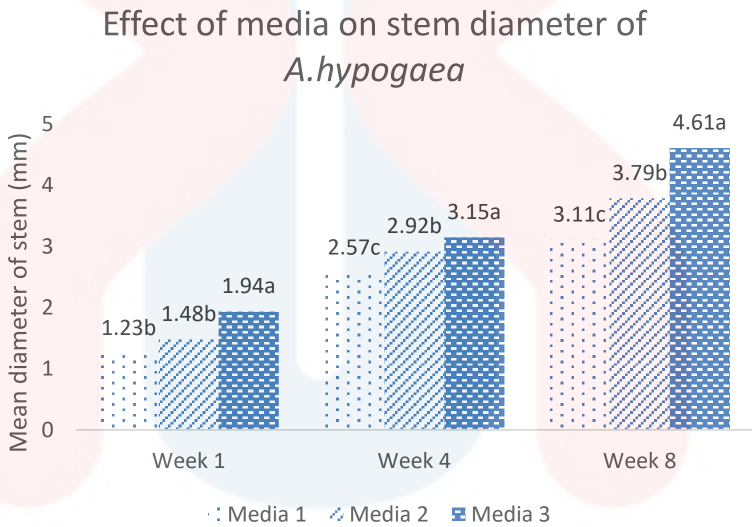

Figure 4.4(b): Effect of media on diameter growth of *A.hypogaea*

4.4 Mean of dry weight of shoot and root

Based on Figure 4.5, only M1SM30 showed that dry weight for shoot is slightly higher compared to the dry weight for root. As for the other treatments, the dry weight of root was higher than the dry weight of shoot was influenced by the weight of groundnut harvested.

The highest mean for dry weight of shoot and root were recorded in M3SM80. The rates of dry weight for this treatment is the highest due to the favourable condition for the plant to grow in soil media under optimum moisture.

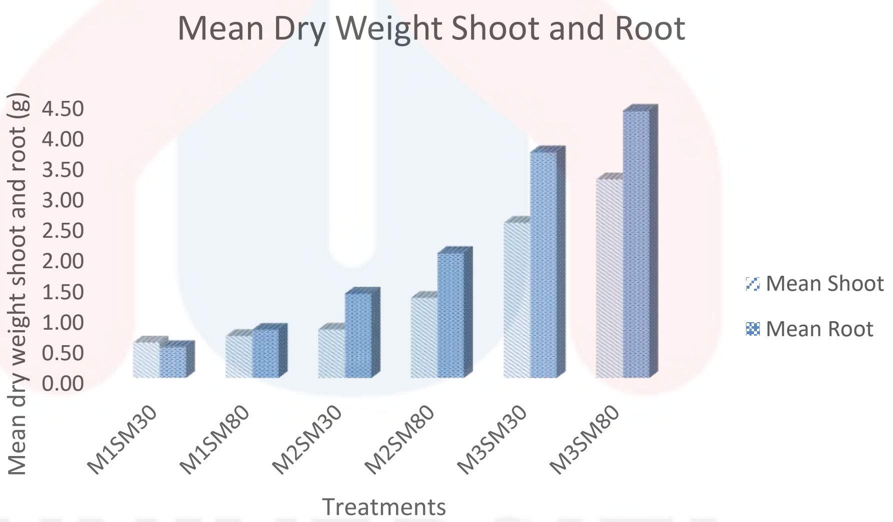

Figure 4.5: Mean of dry weight shoot and root

4.5 Relative Growth Rate

Relative Growth Rate (RGR) indicates the irreversible effects of plant growth rate over the period of time. Table 4.7 showed that M3SM80 had the highest mean of relative growth rate while M1SM30 had the lowest mean. The treatment can be arranged in order of M3SM80>M3SM30>M2SM80>M2SM30>M1SM80>M1SM30

Table 4.7: Effect of treatment on RGR

Treatments	Mean RGR ($g/g^{-1}/day^{-1}$)
M1SM30	0.0014
M2SM30	0.0138
M3SM30	0.0324
M1SM80	0.0066
M2SM80	0.0211
M3SM80	0.0362

The mean was subjected to ANOVA is tabulated in Table 4.8 and only the interaction of media and soil moisture showed no significance effect (p=0.479) on the RGR. Both media and soil moisture showed highly significance effect towards the RGR (p=0.000)

Table 4.8: ANOVA for Relative Growth Rate (RGR)

Source	Degree of Freedom	Sum Square	Mean Square	F-value	P-Value
Media	2	0.003697	0.001849	223.96	0.000***
Soil Moisture	1	0.000177	0.000177	21.50	0.000***
Media x Soil Moisture	2	0.000013	0.000006	0.77	0.479n.s

* Significance difference (p<0.05), n.s non-significance difference (p>0.05)

Tukey's Test was performed to know the mean comparison and the best treatment that contributed to the RGR of groundnut plant. The effect of soil media on RGR is as shown in Figure 4.6(a).

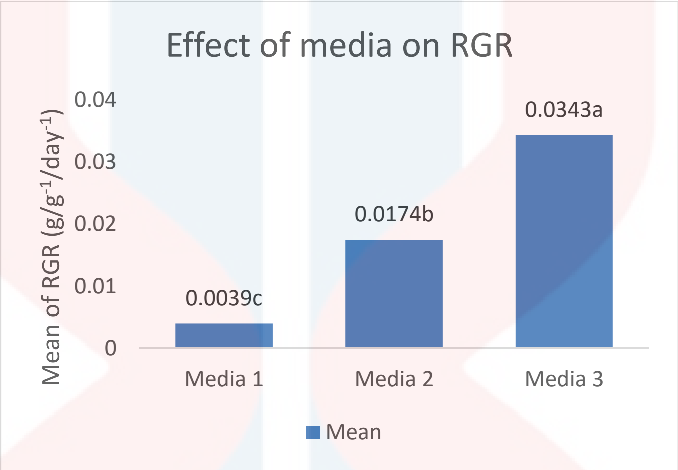

Figure 4.6(a): Effect of media on RGR

Media 3 has the highest mean compared to Media 1 and 2. The media effect towards the RGR can be arranged in order of Media 3>Media 2>Media 1.

Media 3 has the highest significance different compared to Media 1 and Media 2. High amount of carbon content in Media 3 gave the numerous effect on the RGR performance so that only in Media 3 had the highest growth rate compared to Media 1 and Media 2.

Figure 4.6(b) showed Tukey's Test mean comparison of the effect of soil moisture on RGR of groundnut at the end of experiment.

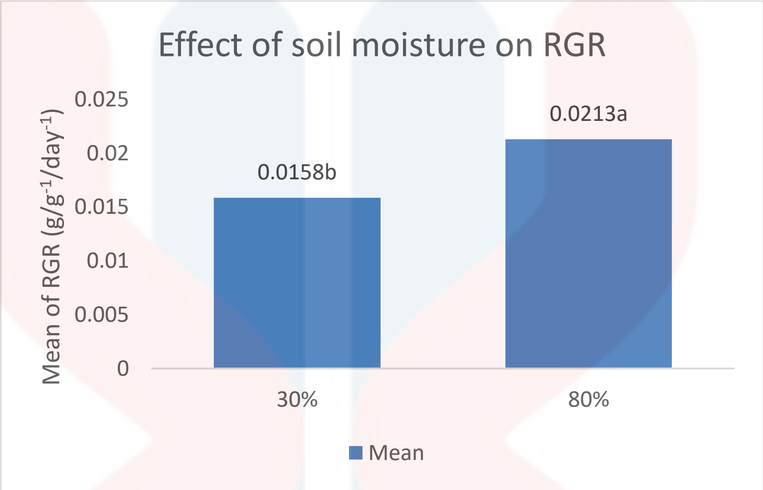

Figure 4.6(b): Effect of soil moisture on RGR

There is significance effect between Soil Moisture 30% and Soil Moisture 80%. Soil Moisture 80% has the highest mean compared to Soil Moisture 30%. Thus, this indicates that Soil Moisture 80% is significantly higher the Soil Moisture 30% in giving the effect on the RGR of groundnut. The soil moisture can be arranged in order of Soil Moisture 80% then followed with Soil Moisture 30%.

The 80% of soil moisture contribute to the growth rate performance of the soil moisture by holding the sandy structure BRIS soil. High moisture content increase the moisture supply of water for the plant to be used during growing period (Moores, 2001).

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the results of the present study, it could be said that level of organic matter (cow manure) has improved the soil fertility and increase the nutrient level for the sandy soil. The plants grow depends on the available nutrients from the addition of cow manure in the soil. The optimum watering frequency also helps in increasing the moisture level for the poor sandy soil. So that the groundnut plants can use up the water and grow in the soil media that rich with organic matters.

In addition, it can be further concluded that the Media 3 combined with 80% of Soil Moisture showed the overall best of the growth performances for all three growth parameters; the number of leaves, height of plant and diameter of stem. The performance of *Arachis hypogaea* was significantly influenced in M3SM80%. From the results obtained, the use of cow manure and optimum moisture content is needed in improving sandy BRIS soil to promote optimum plant growth and yield components of *Arachis hypogaea* is recommended.

Application of cow manure does help to supply plant nutrients including micronutrients, they also improve soil physical properties especially the soil structure. Cow manure act the best as a sandy soil amendment in increasing the availability of nutrients for the plant at once increase the water holding capacity.

It should be noted that growth performance, to a large extent, is controlled by genetic constitution of the plant species. In the future studies, the temporal and spatial components should be taken into the research. Moreover, the specific roles and sensing mechanisms of environmental factors during the seed germination and growth development need to be included in further investigations.

5.2 Recommendations

As a recommendation, individual that need improvement for the sandy soil is advised to add an appropriate amount of organic matter to improve soil properties and enhance crop growth and yield. However to achieve a better result, sandy soil improvement can be made by using the mixture of organic matter either with organic fertilizer or green manure. The appropriate combination approaches to crop production may improve economic viability while reducing the environmental problem. Also, improving the productivity of soil physical and chemical properties.

According to this study, the different reading of devices can be used into the consideration as it can give amount on the effects on measurement of the plant growth performances.

The study could be repeated for a longer period until the yield can be harvested so that an accurate and lasting the impact of organic manure and soil moisture on the soil properties. Further studies are needed to determine the optimal rates of organic manure for proper growth of plant on the abundance sandy BRIS soil.

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APPENDIX A

EXPERIMENTAL LOG

Figure A1: Ruler was used to measure the height of groundnut plant from root to the shoot

Figure A2: The diameter of stem was measured by using digital calliper

Figure A3: Harvested groundnut (M1SM80) for dry weight oven method

Figure A4: Harvested groundnut (M3SM80) for dry weight oven method

Figure A5: Shoot and root were separated for the oven dry

Figure A6: Dry shoot was weighed

APPENDIX B

STATISTICAL ANALYSIS REPORT (MINITAB 17 SOFTWARE)

General Linear Model: Leaves No Week1 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	12.0000	6.0000	3.86	0.040
Soil Moisture	1	0.6667	0.6667	0.43	0.521
Media*Soil Moisture	2	1.3333	0.6667	0.43	0.658
Error	18	28.0000	1.5556		
Total	23	42.0000			

General Linear Model: Leaves No Week4 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	284.333	142.167	5.58	0.013
Soil Moisture	1	20.167	20.167	0.79	0.386
Media*Soil Moisture	2	0.333	0.167	0.01	0.993
Error	18	459.000	25.500		
Total	23	763.833			

General Linear Model: Leaves No Week8 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	43460.3	21730.2	214.56	0.000
Soil Moisture	1	704.2	704.2	6.95	0.017
Media*Soil Moisture	2	836.3	418.2	4.13	0.033
Error	18	1823.0	101.3		
Total	23	46823.8			

General Linear Model: Height Week1 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	92.896	46.4479	57.84	0.000
Soil Moisture	1	22.042	22.0417	27.45	0.000
Media*Soil Moisture	2	2.021	1.0104	1.26	0.308
Error	18	14.455	0.8031		
Total	23	131.413			

General Linear Model: Height Week4 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	194.60	97.302	60.45	0.000
Soil Moisture	1	21.09	21.094	13.11	0.002
Media*Soil Moisture	2	11.91	5.955	3.70	0.405
Error	18	28.97	1.610		
Total	23	256.58			

General Linear Model: Height Week8 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	484.083	242.042	77.45	0.000
Soil Moisture	1	126.042	126.042	40.33	0.000
Media*Soil Moisture	2	1.583	0.792	0.25	0.779
Error	18	56.250	3.125		
Total	23	667.958			

General Linear Model: Diameter Week 1 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	1.94591	0.97295	15.01	0.000
Soil Moisture	1	0.29927	0.29927	4.62	0.045
Media*Soil Moisture	2	0.05791	0.02895	0.45	0.647
Error	18	1.16650	0.06481		
Total	23	3.46958			

General Linear Model: Diameter Week 4 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	1.37410	0.68705	48.30	0.000
Soil Moisture	1	0.01000	0.01000	0.70	0.413
Media*Soil Moisture	2	0.27373	0.13687	9.62	0.523
Error	18	0.25603	0.01422		
Total	23	1.91386			

General Linear Model: Diameter Week 8 versus Media, Soil Moisture

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Media	2	9.1018	4.55088	54.05	0.000
Soil Moisture	1	0.0368	0.03682	0.44	0.517
Media*Soil Moisture	2	0.1568	0.07840	0.93	0.412
Error	18	1.5156	0.08420		
Total	23	10.8110			

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Comparisons for Leaves No Week1

Media	N	Mean	Grouping
M2	8	12.0	A
M3	8	12.0	A
M1	8	10.5	A

Soil Moisture	N	Mean	Grouping
A	12	11.6667	A
B	12	11.3333	A

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	12	A
M2 A	4	12	A

M2 B	4	12	A
M3 A	4	12	A
M1 A	4	11	A
M1 B	4	10	A

Means that do not share a letter are significantly different.

Comparisons for Leaves No Week4

Media	N	Mean	Grouping
M3	8	34.75	A
M2	8	28.00	B
M1	8	27.00	B

Soil Moisture	N	Mean	Grouping
A	12	30.8333	A
B	12	29.0000	A

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	35.5	A
M3 A	4	34.0	A
M2 A	4	29.0	A
M1 A	4	28.0	A
M2 B	4	27.0	A
M1 B	4	26.0	A

Means that do not share a letter are significantly different.

Comparisons for Leaves No Week8

Media	N	Mean	Grouping
M3	8	136.00	A
M2	8	58.25	B
M1	8	37.00	C

Soil Moisture	N	Mean	Grouping
B	12	82.5000	A
A	12	71.6667	B

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	137.0	A
M3 A	4	133.0	A
M2 B	4	71.5	B
M2 A	4	45.0	C
M1 B	4	41.0	C
M1 A	4	33.0	C

Means that do not share a letter are significantly different.

Comparisons for Height Week1

Media	N	Mean	Grouping
M3	8	9.0000	A
M2	8	6.8125	B
M1	8	4.1875	C

Soil Moisture	N	Mean	Grouping
B	12	7.62500	A
A	12	5.70833	B

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	10.250	A
M2 B	4	7.875	B
M3 A	4	7.750	B C
M2 A	4	5.750	C D
M1 B	4	4.750	D E
M1 A	4	3.625	E

Means that do not share a letter are significantly different.

Comparisons for Height Week4

Media	N	Mean	Grouping
M3	8	15.0625	A
M2	8	11.5875	B
M1	8	8.0875	C

Soil Moisture	N	Mean	Grouping
B	12	12.5167	A
A	12	10.6417	B

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	16.875	A
M3 A	4	13.250	B
M2 B	4	11.675	B C
M2 A	4	11.500	B C
M1 B	4	9.000	C D
M1 A	4	7.175	D

Means that do not share a letter are significantly different.

Comparisons for Height Week8

Media	N	Mean	Grouping
M3	8	27.750	A
M2	8	22.125	B
M1	8	16.750	C

Soil Moisture	N	Mean	Grouping
B	12	24.5000	A
A	12	19.9167	B

Media*Soil Moisture	N	Mean	Grouping
M3 B	4	29.75	A
M3 A	4	25.75	B
M2 B	4	24.75	B
M2 A	4	19.50	C
M1 B	4	19.00	C
M1 A	4	14.50	D

Means that do not share a letter are significantly different.

Comparisons for Diameter Week 1

Media	N	Mean	Grouping
M3	8	1.93625	A
M2	8	1.48000	B
M1	8	1.25125	B

Soil Moisture	N	Mean	Grouping	
B	12	1.66750	A	
A	12	1.44417		B

Media*Soil Moisture	N	Mean	Grouping		
M3 B	4	2.1150	A		
M3 A	4	1.7575	A	B	
M2 B	4	1.5425		B	C
M2 A	4	1.4175		B	C
M1 B	4	1.3450		B	C
M1 A	4	1.1575			C

Means that do not share a letter are significantly different.

Comparisons for Diameter Week 4

Media	N	Mean	Grouping		
M3	8	3.15125	A		
M2	8	2.91625		B	
M1	8	2.56875			C

Soil Moisture	N	Mean	Grouping
B	12	2.89917	A
A	12	2.85833	A

Media*Soil Moisture	N	Mean	Grouping		
M3 B	4	3.1550	A		
M3 A	4	3.1475	A		
M2 B	4	3.0750	A		
M2 A	4	2.7575		B	
M1 A	4	2.6700		B	C
M1 B	4	2.4675			C

Means that do not share a letter are significantly different.

Comparisons for Diameter Week 8

Media	N	Mean	Grouping		
M3	8	4.61250	A		
M2	8	3.78875		B	
M1	8	3.10625			C

Soil Moisture	N	Mean	Grouping
B	12	3.87500	A
A	12	3.79667	A

Media*Soil Moisture	N	Mean	Grouping				
M3 B	4	4.7325	A				
M3 A	4	4.4925	A	B			
M2 B	4	3.8575		B	C		
M2 A	4	3.7200			C	D	
M1 A	4	3.1775				D	E
M1 B	4	3.0350					E

Means that do not share a letter are significantly different.