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Effect of compost and green manure to growth performance of *Hibiscus sabdariffa.L* and grown on BRIS soil

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Abstract

Fertility of BRIS soil was evaluated for growth performance of Hibiscus sabdariffa.L (Roselle) and to determine on the potential of Sesbania grandiflora as green manure for improvement of BRIS soil fertility. Growth performance of Hibiscus sabdariffa.L (Roselle) was determined by using three different media; BRIS soil, BRIS soil with compost and BRIS soil with green manure under two different light conditions (30% and 50%). The growth performance analysis of Roselle was carried out in the study to determine the effects on height of stem, number of leaves, stem diameter and biomass production (fresh and dry weight) of Roselle plants. The result showed that, the highest performance of stem height of Roselle was in BRIS soil with compost under 30% light intensity, while the best performance in term of number of leaves was BRIS soil with compost under 50% light intensity. In term of stem diameter, the highest value was in BRIS soil with compost under 50% light intensity. The highest performance of biomass production (fresh and dry weight) of roots, stems and fruit was treatment BRIS soil with compost under 50% light intensity. Based on statistical analysis using non-parametric method, the result indicated that there was significant different in the comparison of media BRIS soil and BRIS soil with compost under two different light conditions (30% and 50%). However, there was no significant different in comparison of media BRIS soil and BRIS soil with green manure. BRIS soil with compost showed the highest potential for growth performance of Roselle. In conclusion, compost is the best treatment that suitable for BRIS soil as it improves the fertility and structure of BRIS soil. Similarly, the light condition of 50% was better than 30% as sufficient amount of light is important for photosynthesis process and for growth and yield of plants.

1. INTRODUCTION

BRIS soil is stand for Beach Ridges Interspersed with Swales. BRIS soil is the sandy soil usually has at the beach areas. BRIS soil is a problematic soil and has poorly drained or excessively drained land. BRIS soils in the coastal region of Malay Peninsula have been known to be successful in growing Tobacco, with the combination of waste products such as chicken manures and palm oil extracts and also can improve with the development of the soil quality (Abdussalam *et al.,* 2013). According to Hanafiah *et al., (*2004), BRIS soil is compost mainly of quartz with minor amounts of heavy minerals. The free-draining soil is contains weather able minerals that soil are sufficiently fertile to grow a range of crops where these minerals have all been lost by leaching because the soil has low fertility and not used. The poorly drained soil have low fertility and frequently not used for agriculture (Panton, 1958). The BRIS soil disadvantages is that it cannot store water for long periods. BRIS soil has a high percentage of sand and this hinders the growth of plants. As a result of low in nutrients uptake of these plants which might be the source of the organic materials in the soil can be responsible for the emission of acidity, which lead to the development of acidic humus, thereby forming moor humus at the soil surface (Roslan *et al.,* 2010).

Roselle or the scientific name *Hibiscus sabdariffa L.* is an important crop in tropical and sub-tropical regions. *Roselle* is dicotyledonous and autogamous plant cultivated. Regarding to Siti Nur Sarah, (2012) decribed that *Roselle* is an annual plant with shrub-sized tree and can grow to a height of 205 centimetres (cm). *Roselle* thrives in mineral soil and when planting in BRIS soil good watering and fertilizing is needed for high growth and yield. *Roselle* suitable for planting in any area as long as it getting enough sun and

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good water supply. *Roselle* is a shrub plant. The plants can be planted with a wide range of soil conditions. A relatively infertile soil is sufficient for it to grow for domestic cultivation. At the same time, the soil needs to be rich in organic, materials and nutrients for commercial cultivation. Moreover, the *Roselle* is not suitable to be planted in the rainy season (monsoon) because the risk of facing the problem of fungal diseases on leaves, stems and fruit. However, *Roselle* is suitable to be grown due warm and humid climate because will help cultivation of the *Roselle* crop. *Sesbania grandiflora* was chosen as cover plants and green manure because is well adapted to hot, and humid environments. The trees that can survive in lack of sources situation. *Sesbania grandiflora* is known as hardy plant because lowland species that is lacking tolerance for cool temperature (Orwa *et al*., 2009).

Therefore, this study was conducted to obtain a better understanding of the fertility of BRIS soil to assess the level performance growth of *Roselle.* Moreover, the further studies on *Sesbania grandiflora* as a subject in green manure BRIS soil also need to be conducted to provide information related with it potential of fertility of BRIS soil toward growth performance of tree. The main focus of this study is to evaluate the fertility of BRIS soil towards growth performance of *Roselle* and to discover on the potential of *Sesbania grandiflora* as green manure in term of silviculture treatment and fertility of BRIS soil. The purpose of the experiment is determine the growth performance and biomass production of *Hibiscus sabdariffa.L* in three different medium; (BRIS soil , BRIS soil with compost and green manure BRIS soil) under two different light intensities (50% and 30%).

This research project were observed and identify the quality nutrient in *Roselle and Sesbania grandiflora* as green manure fertilizer. This study also may contribute to the country and society through information on fertility of BRIS soil and obtained from the analytical data of crop yields such as crop growth performance, the height and diameter of stem, number of leaves. The results obtained can be used as examples and references to future generations.

2. MATERIALS AND METHODS

2.1. Preparation samples and site

A small area measure 5m x 5m in Agro Park UMK Jeli was cleared and plastic mulching sheet was installed along the project site to avoid the grass grow. The basic Split-Plot Design involves assigning the levels of factor (A - light intensity) to main plots arranged in a Complete Random Design, and then assigning the levels of a second factor (B - Media) to subplots within each main plot with 5 replication . In each plot there were 3 rows of 5 m length. The polybags arranged in accordance with light intensity plot intensity of 50% and 30%. Referring to Wersal and Madsen (2012) that 50% better lighting to the plants as compared with 30% as the plant gets enough light for photosynthesis The light intensity were measured by using light meter and be divide into 50% of light intensity and 30% of light intensity in the plot by using net. The nets supported by poles from PVC rod. *Roselle* seeds were soaked in warm water until germinate before sown in polybags. Then, formula of growth percentage from Eq. (1) are used to determine the growth percentage of seed.

$$\text{Growth performance} = \frac{\text{seed germination}}{\text{total seed}} \times 100 \quad \text{Eq. (1)}$$

BRIS soil was taken at UMK Bachok. Before it being put into the polybag accordance ratio and media, the BRIS soil must be isolated other matters that are not needed by using plastic filter. BRIS soil was converted into three media, namely BRIS soil in ratio 1:0, BRIS soil mixed compost in ratio 1:2 and green manure BRIS soil in ratio 1:2 (Md. Sarwar *et al.*, 2014). *Sesbania* leaves dried under the sun for 72 hours (3 days) to remove the water in the leaves. Compost used is from vegetable waste. After mixing the BRIS soil with different media (BRIS soil, BRIS soil mixed compost and BRIS soil mixed green manure), the different media treatment were filled into polybag accordance the quantity of the same weight to each polybag. The suggestion suitable quantity of water is 4 litres (Naimah *et al.,* 2014). The trees should be watered twice daily to ensure adequate water in trees and soil. The suggestion time according to journal from Naimah *et al.,* (2014), is suitable twice a day at time 9:00 am to 10:00 am and 5:00 pm to 6:00 pm.

For survival of sapling growth experiment, treatments of the experiment are conducted in Complete Randomized design with 5 replications. 50 of *Roselle* seeds was soaked in water for one day and sown into the trial tray. Readings of seed germination were taken from the seeds soaked and successfully to be saplings. Then, 30 of *Roselle* seedlings were sown into 30 polybags (12 cm x 23 cm). Each treatment consist of 30 polybags seedlings of *Roselle* in three different of BRIS soil. *Sesbania grandiflora* were mixed thoroughly with the soil BRIS as green manure fertilizer.

All of observation on survival of cutting were recorded at the time of roots initiation and growth parameter at the time of transplanting for all of 30 trees for survival percentage. The data on survival percentage of growing was recorded according to growth ability (height of stem, number of leaves, diameter of stem and biomass production). Plant height were recorded by measure from polybags top soil surface up to the highest of leaf tip by straightening the stem. Diameter of stems was recorded by using digital Vernier calliper. Plant growth performance was recorded along progresses time

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and transplanting at the end. Plant height and stem diameter were expressed in cm and mm. The roots length are measure by destructive method of uprooting the plants and taking measurement by standard method. Lastly, fresh and dry weight of the plant (fresh weight of stem, roots and fruits) was recorded before and after 48 hours reduction of moisture from the *Roselle*.

The samples were washed through two sieves (1.41 mm and 600 µm diameter pore size) to remove any excess soil from the roots and placed into pre-weighed glass dishes. Plants were placed in resealable plastic bags, kept cool, weighed, and dried in accordance with the weighting. If the plants cannot be weighed for fresh weight in the field, it must be transported to the laboratory or another appropriate facility in plastic bags on wet ice and weighed within 48 hours. Then, the fresh weight was recorded and dried at 60°C for 24-48 hours in oven. After drying, the samples need to be reweighed to record the dry weight of samples. The process of drying *Roselle* plants were conducted in constant temperature that is four temperatures (35, 45, 55, and 65°C) for 48 hours in oven. Drying air temperature was found to be the main factor affecting the drying kinetics of *Roselle*; rising the drying temperature from 35°C to 65°C intensely reduced the drying times.

2.2. Experimental design and site layout

Experimental design is comprise of different factors (A and B) in Split Plot Design. Factor A is the main plot factor with 2 levels (A and B) while factor B is subplot factor with 3 levels (a, b and c). T_{Ba} represent of BRIS soil with ratio (1:0) under light intensity 50%, T_{Aa} represent of BRIS soil with ratio (1:0) under light intensity 30%, T_{Bb} represent of BRIS soil with compost (1:2) under light intensity 50%, T_{Ab} represent of BRIS soil with compost (1:2) under light intensity 30%, T_{Bc} is represent of green manure BRIS soil (1:2) under light intensity 50%, T_{Ac} is represent of green manure BRIS soil (1:2) under light intensity 30%. While R represents the number of plants replicate in a plot. There are 3 replications per main plot. Referring to random table from Washington State University (2000), Complete Randomized Design (CRD) layout arrangement subject were used in this study for simplest of all designs. A group of experimental subjects is considered a single independent experimental unit. There are 2 (A-B) treatments with 5 replications each. Descriptive statistic, Kruskal Wallis test and Mann Whitney U test from SPSS software version 2.1 were used to analyse not normally distributed data.

3. RESULTS AND DISCUSSION

3.1. Height of stem

Table 1 (a) and (b) shown that the comparison in height of stem for *Hibiscus sabdariffa.L* (*Roselle)* by using Kruskal Wallis and Mann Whitney U test. In Kruskal Wallis test shown that there are a significant different among this three media of BRIS soil, BRIS soil with compost and BRIS soil with green manure under different lighting condition (30% and 50%) with (α=0.000) at 0.05 significant level. However in Mann Whitney test shown it was not significant different at comparison between media BRIS soil and BRIS soil with green manure under 30% lighting with (α=0.160) at 0.05 significant level. There are also not significant comparison of BRIS soil and BRIS soil with green manure under 50% lighting with (α=0.328) at 0.05 significant level. Therefore, the highest height of *Roselle* stems is at BRIS soil with compost under 30% light intensity which at (65.12). It prove that the *Roselle* have good performance growth of height at BRIS soil with compost media in 30% lighting condition. The low light-induced absence reduced photosynthetic supply effect. In the absence of such effects, an injected plant might be expected to achieve the same size and shape as an uninfected plant under greater light intensities (Sultan.H *et al*, 2002). The common fungal disease also that attacks *Roselle* roots and stem is *Coniella rnusaiaensis var.Hibisci* and *Phoina spp.*

Table 1(a): Comparison of height of *Roselle* stems by three different media and two different intensities by using Kruskal Wallis.

Light condition (%)	Chi-Square	Asymp. Sig.
30	34.000	0.000
50	17.853	0.000

Note: Chi-square followed by Kruskal Wallis test, contrasts significant and no significant, respectively, at (p≤ 0.05).

Table 1(b): Comparison of height of *Roselle* stems by three different media and two different intensities by using Mann Whitney U test.

Light condition (%)	Media	Mean rank	Asymp. sig
30%	BRIS	35.88	0.000
	BRIS + compost	65.12	
	BRIS	54.58	0.160
	BRIS + GM	46.42	
	BRIS + compost	64.78	0.000
	BRIS + GM	36.22	
50%	BRIS	40.03	0.000
	BRIS + compost	60.97	
	BRIS	53.34	0.328
	BRIS + GM	47.66	
	BRIS + compost	60.97	0.000
	BRIS + GM	40.03	

Note: Mean rank, contrasts significant and no significant, respectively, at (p≤ 0.05). (GM= green manure)

3.2. Number of leaves

Table 2(a) and (b) shown that the comparison of number of *Roselle* leaves between three different media; (BRIS soil, BRIS soil with compost and BRIS soil with green manure) and two light intensities (30% and 50%). From Kruskal Wallis test show that there are a significant of the three different media of BRIS soil, BRIS soil with compost and BRIS soil with green manure in light intensity of (30% and 50%) with (α=0.000) at 0.05 significant level. In Mann Whitney test shown, there are not significant comparison between media BRIS soil and BRIS soil with green manure at 30% lighting with (α=0.426) while it was also were not significantly different comparison between media BRIS soil and BRIS soil with green manure under 50% lighting with (α=0.087) at 0.05 significant level. Table 3.2 shown that the highest of mean rank of number of leave was from media BRIS soil with compost under 30% light intensity that was (69.91). In observation of study, the factor of light intensity and compost give effect to growth number leaves of *Roselle.* The factor of effect number of leaves decrease is disruption of insect pests such as snails, caterpillar, grasshoppers (*Valanga nigricornis)*, black citrus aphid and white moth.

Table 2(a): Comparison of number of leave by three different media and two different intensities by using Kruskal Wallis

Light condition (%)	Chi-Square	Asymp. Sig.
30	48.673	0.000
50	29.404	0.000

Note: Mean rank and chi-square followed by Kruskal Wallis test, contrasts significant and no significant, respectively, at (p≤ 0.05).

Table 2(b): Comparison of number of leave by three different media and two different intensities by using Mann Whitney U test

Light condition (%)	Media	Mean rank	Asymp. sig
30%	BRIS	31.09	0.000
	BRIS + compost	69.91	
	BRIS	48.23	0.160
	BRIS + GM	52.77	
	BRIS + compost	65.43	0.000
	BRIS + GM	35.57	
50%	BRIS	34.18	0.000
	BRIS + compost	66.82	
	BRIS	45.56	0.087
	BRIS + GM	55.44	
	BRIS + compost	59.39	0.002
	BRIS + GM	41.61	

Note: Mean rank, contrasts significant and no significant, respectively, at (p≤ 0.05). (GM= green manure)

3.3. Diameter of stem

Table 3(a) and (b) showing the comparison of the diameter of *Roselle* stem between three different media; which is (BRIS soil, BRIS soil with compost and BRIS soil with green manure) compare to two lighting condition (30% and 50%). From the Kruskal Wallis test shows there are a significant with (α=0.000) at 0.05 significant level in the three different media under two lighting (30% and 50%), however, in Mann Whitney test shows there are no significant differences of media BRIS soil and BRIS soil with green manure in 30% lighting with (α=0.334) at 0.05 significant level and also from BRIS soil and BRIS soil with green manure in 50% lighting with (α=0.733) at 0.05 significant level. The Table 3.3 shown that the highest of diameter of *Roselle* stem was at BRIS soil with compost in lighting 30% at (65.41). The shading of place impact on soil moisture besides maintains sufficient nutrients to the plants. Regarding to Sultan *et al*, (2002), the shading under 75% changes in structure and moisture of soil, suggesting that these effects are strictly due to light intensity and not related to photosynthetic availability. From this study prove that compost be able to help giving nutrient and repair structure of soil in order to improve stem growth from get enough water because rising of soil moisture (US Composting Council, 2008).

Table 3(a): Comparison of diameter of Roselle stem by three different media and two different intensities by using Kruskal Wallis

Light condition (%)	Chi-Square	Asymp. Sig.
30	27.911	0.000
50	18.582	0.000

Note: Mean rank and chi-square followed by Kruskal Wallis test, contrasts significant and no significant, respectively, at (p≤ 0.05).

Table 3(b): Comparison of diameter of Roselle stem by three different media and two different intensities by using Mann Whitney U test

Light condition (%)	Media	Mean rank	Asymp . sig
30%	BRIS	35.59	0.000
	BRIS + compost	65.41	
	BRIS	47.70	0.334
	BRIS + GM	53.30	
	BRIS + compost	61.52	0.000
	BRIS + GM	39.48	
50%	BRIS	38.74	0.000
	BRIS + compost	62.26	
	BRIS	49.51	0.733
	BRIS + GM	51.49	
	BRIS + compost	60.24	0.001
	BRIS + GM	40.76	

Note: Mean rank, contrasts significant and no significant, respectively, at (p≤ 0.05). (GM= green manure)

3.4. Fresh and dry biomass production

Figure 1 (a) and (b) shows the mean of fresh and dry biomass production in term of roots, stem and fruit *Hibiscus sabdariffa.L (Roselle)*. The highest mean of roots in fresh weight was at BRIS soil with compost under 50% lighting with (8.86 g) while the lowest mean roots was at BRIS soil under 30% lighting with (0.59 g). The highest mean of stem was at BRIS soil with compost under 50% light intensity with (61.11 g) while the lowest mean of stem was at BRIS soil under 30% light intensity with (0.53 g). The highest mean of fruit in fresh weigh was at BRIS soil with compost under 50% lighting with (4.66 g) while the lowest mean of fruit was at BRIS soil under 30% light intensity with zero weight. The highest performance of fresh weight biomass production was at BRIS soil with compost under 50% light intensity which roots (8.86 g), stem (61.11 g) and fruit (4.66 g). In observation, the better performance of fresh weight biomass production in roots, stem, and fruits was at BRIS soil under 50% lighting because the *Roselle* received adequate sun and the BRIS soil received nutrient and mineral from compost. This study proved that adequate lighting can help the process of photosynthesis and biomass production of stem, roots and fruit of *Roselle.*

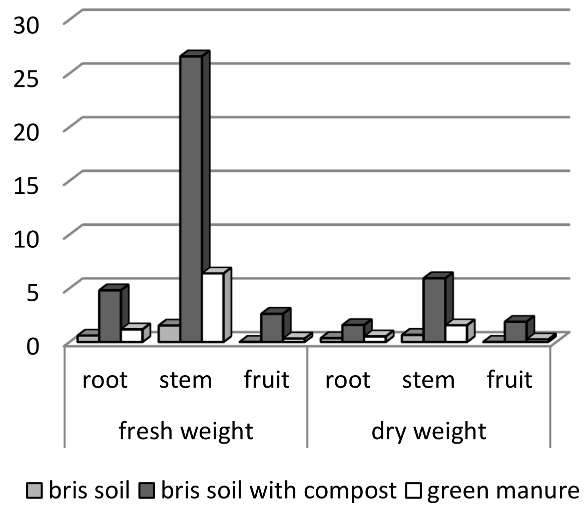

Figure 1(a): Mean of fresh and dry biomass production in 30% light condition.

The highest mean roots of dry weight was at BRIS soil with compost under 50% lighting with (2.99 g) while the lowest mean roots of dry weight was at BRIS soil under 30% lighting with (0.35 g). The highest mean of stem dry weight was at BRIS soil with compost under 50% lighting with (12.08 g) while the lowest mean of stem of dry weight was at BRIS soil under 30% light intensity with (0.65 g). The highest mean of fruit of dry weight was at BRIS soil with compost under 50% lighting with (3.48 g) while the lowest mean of fruit was at BRIS soil under 30% light intensity with zero weight. In observation, the highest of biomass performance is because factor of lighting which the adequate sun can help in plant photosynthesis and growing. However, the lowest performance of biomass production was at BRIS soil under 30% lighting because the *Roselle* cannot receive more sun lighting to support the above and below *Roselle* trees. The low lighting also can because fungus infected to *Roselle* trees and reduced performance of height, number of leaves and diameter of stem.

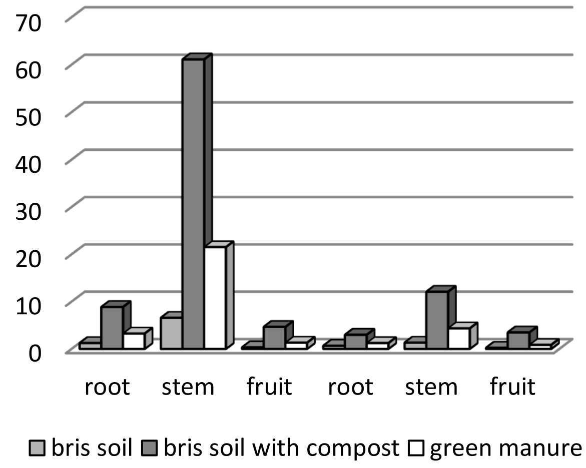

Figure 1(b): Mean of fresh and dry biomass production in 50% light condition.

4. CONCLUSION

Based on this study, there is significant different between three different media and two different light intensities (30% and 50%). The successful result from growth performance of *Roselle* height was in BRIS soil with compost under 30% of light intensity, while the best performance number of leaves was at BRIS soil with compost under 50% lighting intensity. In term diameter of stem growth performance, the highest was at BRIS soil with compost under 50% light intensity. The better performance of biomass production (fresh and dry weight) was at BRIS soil with compost under 50% light intensity. The result of fresh and dry weight biomass are better to improve growth performance of plants highlighted at treatment media BRIS soil with compost that is suitable to increasing fertility of BRIS soil because it improves water holding capacity, thus reducing water loss and leaching in sandy soil. Besides that, the characteristics of Roselle with a strong tap root and high moisture stress tolerance allowed it to fit efficiently in areas with limited water. Besides that, the well aerated soil may increase the efficiency of root in water uptake under water stress condition (Babatunde and Mofoke, 2006). The effects of moisture content and locality of harvest on some physical properties of *Roselle* seeds range of 13 to 25% (Sánchez-Mendoza *et al.*, 2008).The suggestion accordingly from this study, the

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best media treatment was BRIS soil with compost; however the light intensity is depends on the growth parameters. The light condition 50% was better than 30% because light is the one important treatment for photosynthesis process and required for growth and yield of plants.

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