Luffa Gourd Production Practices from Transplanting and Direct Seeding Methods for Composite Productions

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Abstract. World is facing an increase of environmental concerns recently regarding on natural and synthetic fibers problems. Producing synthetic fibers may cost highly and create a few financial issues on the production matter. Moreover, synthetic fiber products have several disadvantages such as they are non-biodegradable. Some of them may cause health related problems and expose a significant risk. Researchers aimed to find the replacement for synthetic fibers with less cost production and renewable sources which lead to development of biomaterials-based composites production. Luffa is an eco-friendly crop, has been added as the new fibrous fruit with short harvest period. This study have applied a few practices using direct seeding and transplanting methods for low cost luffa production that aim for composites production. On the other hand, this study showed that transplanting (TP) method is better than direct seeding (DS) method based on the growth performance. TP method showed highest average of plant height (cm) and average total dry weight (g) of luffa fruits with 74.42±0.68 and 91.08±2.26 respectively whereas lower growth yield performance showed by DS method. Other parameters observed are the number of leaves and number of fruits which is a competent sources to the current composites sources, synthetic fibers. Hence, the results showed that luffa has the potential as a low cost and short harvest duration production plant.

1. Introduction
Eco-friendly materials and products are important as they change our quality of life. As a matter of fact, eco-friendly products are safe and protect environment from pollution. Researchers begin to exploit natural fiber’s sources as substitution for the synthetic fiber and solve environment related issues [1]. Natural fibers
are important agricultural biomass contributing to Malaysian economy [2] and can be expected to continue the upward trend in Malaysia, reflect population and income growth. The increasing import of raw natural fibers to meet domestic needs and the development of re-export trade appear less has become the major factor that contribute to the importance of fiber’s substitution. The only problem of fiber crops cultivation in Malaysia lately is the increase of extreme weather events that create unfavorable condition for plantation industry, thus expanding the cost of production. Research and development need to be done for achieving better material of alternative sources natural fiber. It has been reported that although plant fiber is lack of adhesion compared to the synthetic polymeric matrices, such drawback can be reduced with appropriate treatment [3]. Yield of plant fiber can be developed by producing hybrid composites as they showed better impact result and performances [1].

*Luffa acutangula* L. is commonly known as luffa or loofah and other common name as Ridge gourd which come from Cucurbitacea family [4]. The fruit is cylindrical, greenish brown in colour with bitter in taste, tapered toward the base and cover with 8-10 prominent ribs [5]. It has been centuries since luffa gourds are cultivated in Middle East, India, China, Japan and Malaysia. *Luffa* gourd is a plant material that has short harvesting period, environmental friendly crop and cost effective since it requires less water and minimum care for growth. *Luffa*’s demand in Asia is high and increasing since it has been used commonly for various purposes such as for personal hygiene, household cleaning materials as well as in skin care products [6]. Another fiber substitutes with high demand in the market today are luffa and pineapple with one year life cycle. By using fibers from one year plants, it can be a quicker and economically favorable production of composites based on environmentally friendly, abundant renewable materials with short growth cycles [7]. In this study, besides identifying the growth and yield performance of luffa as fiber crop, determining the planting cost effectiveness is also one of the objectives. Apart from that, demand for fiber products has elevated remarkably and many firms are trying to expand the valuable opportunity in helping conventional farmers [2].

2. Materials and Methods

2.1 Plot Preparation for Direct Seeding Method (DS) and Transplanting Method (TP)

A total of sixteen (16) planting beds were prepared with the measurement of 7.20 ft in length, 18.00 ft in diameter and 1.00 ft in height. The distance in between the planting beds were 5.40 ft. The planting beds were covered with polyethylene plastic (0.8 mm thickness) as a mulch. Each planting bed contained 3 rows and 5 columns with 2.5 cm depth planting hole with 46 cm apart. The planting hole was made using bulb planter. Next, the vertical trellis system (1.5 m) was constructed using wood post (10 cm X 10 cm) and steel pipe (2.5 cm diameter) prior to the cultivation method. Several individual strings were suspended over each planting hole to act as support system for the plants to climb upwards. The plot for direct seeding and transplanting methods in this experiment were labelled as DSR (Direct Seeding Replication) and TPR (Transplanting Replication) with four (4) replications.

For the DS method, two luffa seeds were sowed directly to each planting hole. After 3 weeks of cultivation, the DS seedlings were thinned to one seedling only by selecting a healthy and complete four lateral shoots. The DS seedling was tied to the suspended strings as needed. Meanwhile, for the TP method, the luffa seeds were soaked in water for 24 hours prior to be sown in plastic flat (5 cm X 5 cm cell). Two (2) soaked luffa seeds were sown in each cell. Then, the four (4) weeks old seedlings were transplanted to the prepared planting bed. The healthy and complete TP seedlings with four lateral shoot were tied to the suspended strings as needed. Both DS and TP seedlings were watered twice a day and fertilize with 100 mg of 20: 4.4: 16.6 (NPK) of fertilizer per liter (L).
2.2 Data collection and Analysis
From week 1 to week 5, the data on number of leaves and plant height (cm) for both DS and TP plants were observed and collected. Meanwhile, total number of fruits for both DS and TP was collected from week 5 to week 9. Next, total of luffa fruit per planting bed and the size of luffa fruits (cm) were measured in week 9 before the luffa fruits on the trees were left to dry naturally for two weeks in week 10 – week 12 where the luffa fruits either shrunk or rotten. The amount of lost fruits during the drying process were recorded. Subsequently, the natural dried luffa fruits and a few fresh luffa fruits were harvested and air-dried for one week in week 13. The dry weight (g) of dried luffa fruits were measured. The experiment was conducted using Randomized Central Block Design (RCBD) factorial method. The collected data were analyzed by using SPSS (Statistical Package for the Social Sciences) 24.0 software at 5% significance level.

3. Results and Discussion
Evaluation of luffa gourd production can be made at the first week of planting since it had shown growth development. Luffa seed germination is often slow and sporadic [8]. To obtain a sturdy plant stand, luffa gourd usually produced from transplants. Data recorded were based on plant height (cm), number of leaves and number of fruits parameters. Two types of planting methods had been carried out, DS and TP. Regardless of the two planting methods, most of the plant survived for both. The germination rate obtained for both methods were similar with 75% - 80% by sunlight exposure within the range of temperature at 29oC-31oC. The soil pH for the luffa sponge gourd to grow was around 6.0-6.8 and grown on the soil with about 18oC [9]. A few weeks after planting the seeds, as the plant grew, flower buds also had bloomed.

3.1 Height of Luffa Plant Production from Week 1 to Week 5
From observations, the TP showed a higher growth rate compare with DS. The germination rate was almost similar but TP results was better. Table 1 shows the average of main stem plant height for four replicates of DS and TP plant in week 1 until week 5.

| Week | DS (direct seeding) | TP (transplanting) |
|------|---------------------|---------------------|
| 1     | 5.20±0.13           | 6.19±0.12           |
| 2     | 10.77±0.57          | 19.78±0.22          |
| 3     | 23.07±1.14          | 45.30±0.53          |
| 4     | 62.37±5.27          | 63.42±0.75          |
| 5     | 71.05±5.41          | 74.42±0.68          |

Plant height for DS and TP plants were gradually increased in length throughout the five weeks. Both literally had a quite similar results for early observations because during that stage, plants were elongated upward towards the sunlight for photosynthesis process. Starting from week 3, there were an active spurt of growth and a huge difference from the previous week since the plant begin to mature and grow taller. TP plant were higher compared to DS plants throughout the five weeks with 74.42±0.68 and 71.05±5.41 in cm respectively. One of the factors could be that seedlings from TP plants had been taken care before acclimatization stage. Due to the conditions under control before, it may result in a better growing process. Factors that affect the growth were light, water, temperature and nutrients [10]. That is why TP luffa had a consistent growing of plant height compared with DS plant. For DS plant, it also increased in plant height consistently recorded in 5 weeks but slow growth rate for the stem grow and mature. Similar distributions of the growth elements (light, water, nutrient, temperature) might be given to both types of method planted [11]. As leaf size increase, plant stem need to be proportionately strong in order to support their own weight. In this case, luffa’s leaf for direct seeding method might be bigger than transplant method which
made the height decreased or the plant could not support the exceeding new weight gain. These result was in agreement with the findings of [6] who agreed that TP method showed better results compared to the DS according to the study, up to 90 to 100% of survival rate in transplanting method had been reported compared to the direct seeding which only showed 74% of survival rate. The highest average of luffa plant height at the end of week is within week 5 for both methods dictated by environmental conditions. Another factor that could lead the possibility of the plant height performance was the angle of growth branches which may intercept main stem to grow. [6] also reported that a growing season of luffa of short period is not enough to produce luffa from seeds and transplants in short growing season should be set in field as soon as all danger of frost is past. Statistical analysis proved that there is significant difference for plant height between DS method and TP method with $P > 0.05$.

3.2 Number of Leaves for Luffa Plant Production from Week 1 to Week 5

Table 2 showed the difference of number of leaves of luffa for DS method and TS plant method. The number of leaves were also growing within five weeks. It was increased for each weeks and advance rapidly from week 3. For both methods, the growth performance were improved for the third week and above since they had reached the maturity stage to grow.

| Week 1     | Week 2     | Week 3     | Week 4     | Week 5     |
|------------|------------|------------|------------|------------|
| DS         | 4.04±0.13  | 13.81±0.84 | 49.85±1.65 | 80.42±5.08 | 76.89±4.88 |
| TP         | 6.17±0.34  | 17.94±1.58 | 64.69±3.76 | 69.19±3.76 | 74.52±3.76 |

In week 4, DS method plant number of leaves was the highest with 80.42±5.08 and surprisingly decrease on week 5, 76.89±4.88. it is because of several leaves that wilted and fell to the ground in the interval time. Due to the unexpected weather change these days, it may affect luffa’s growth. Hot and dry weather probably made the plant wilted faster even though a frequent plant watering schedule had been done. Meanwhile, TP method number of leaves were consistently growing throughout the week compared to DS plant. In week 4, DS plant number of leaves had overgrown TP leaves growth. Moreover, this number of leaves also related to the plant height measurement. Many leaves on DS plant made the height distorted as they cannot support the leaves weight and become shorter than TP plant height. TP luffa plants performance was steady and smoothly increased. Based on the experiment results, the statistical analysis also proved that there is significant difference for number of leaves between DS method and TP method with $P > 0.05$.

3.3 Number of Fruits for Luffa Plant Production from Week 5 to Week 9

Besides that, number of luffa fruits also had been recorded and showed that TP was better than DS. Fruits growth can be observed starting from week 5 and grew until week 9. In addition, the flower bud also can be seen and blooming. Total average of fruits growth as in graph 1 was shown within 5 weeks periods.
TP method showed that number of luffa fruits produced was higher compared with DS of fruits produced. During week 8, both method TP and DS practices had the highest record of average luffa fruits number per plant with 3.69±0.16 and 3.25±0.25 respectively. However, in week 9 the number of fruits dropped immediately because most fruits fell on the ground. It was suspected that heavy rainfall may cause the fruits to be plucked out from the branch. Based from the observations made, all plant method replications had successfully producing the fruits and continue to grow. Figure 1 shows luffa fruit in week 9 for both DS and TP methods. Number of fruits produced was consistently recorded every weeks. Due to the maturity phase and unexpected weather changes, some of the fruits had wilted and also fell on the ground before data collection for that particular week.

**Figure 1.** Average number of luffa fruits from week 5 to week 9 for DS and TP

Within week 10 until week 12, the fruits were left to air dry naturally on the plants. Unfortunately, there were lots of loss for luffa fruits. Some of the fruits shrunken and rotten on the plant, which has been

**Figure 2.** Luffa fruits in week 9 a) Luffa fruit from TP method b) Luffa fruit from DS method
discussed due to the unforeseen weather changes. Some of the fruits were able to be saved and plucked from the plants and left to dry in a close area. In week 13, luffa fruits on the plants were harvested to avoid more loss. The fruits dry weight were obtained in comparison for both methods. By letting them to air dry, the luffas started to lose water weight [12].

It is important to let the luffas dry in the warm and ventilated area. If they were left drying in a wet and moist condition, by the time the fruits may discolor. The use of luffa fruit is depend on its growth stage maturity. The immature fruit compare with mature fruit is likely nutritious and mostly eaten in Asian cuisine [13]. Whereas mature stage of luffa fruit has many goods that can be applied in many industries as new products form [14]. The more mature they were, better sponge fiber quality obtain. Average total dry weight fruit per plant in week 13 for DS and TP was shown in graph 2.

The graph shows that TP has the highest average dry weight (g) of luffa fruit compared to DS with 91.08±2.26 and 72.33±5.77 respectively. Since TP luffa fruits had grown consistently from the beginning of the week, it showed a great growth performance. With the existing of limitation that could contribute in plant growth and fruit deformation should be constricted. Good conditions are essential for better growth performance but, excessive water can also result in a low growth production and root diseases [11].

Both methods DS and TP have pros and cons to be studied. As both can be useful in cultivation method to ease the farmers and along the way to increase luffa yield production too. According to [13], direct seeding is fast method and can save labor energy but cannot be used after the season. Meanwhile transplanting method is a bit complicated method which requires more labor consuming but can expand harvest season and can obtain earlier harvest. Thus it shows that methods planting can affect the yield performance and production.

Luffa is one of the attractive plant that has natural fiber material. According to [10], luffa is one of vegetable types that can be eaten and very fibrous when they fully ripened. The advantages have been look up by many people to exploit in certain industries such as health and cosmetic. As mentioned by [15], several values from lignocellulosic fiber-reinforced composites in luffa can be its own advantages which include biodegradability, low density and high tensile strength, renewable sources, lower price than synthetic fibers and less abrasive.
3.4 Cost Effectiveness on Growing Luffa

In Malaysia, commercial luffa cultivation is less due to the lack of exposure about this plant production system. Therefore, one of the outcomes from this research is low cost budget production can be applied in production of luffa’s planting. As the demand for fiber products has increased higher than before, many industries and big companies have jumped on this opportunity to grow more fiber crops. Besides, low cost plant production were mostly designed to help small farmers in plantation. In other words, farmers with financial situation can be affected by all sorts of environmental risks such as unseasonable weather. It is believe that local growers can grow this crop well as it provides a profitable and unique economic properties.

4. Conclusion

TP method of planting luffa has shown better result compared to DS method through this project study. Further study from this research can identify fiber content in luffa fruits and compare both between planting methods. The information obtained from this study may help the potential farmers to prepare themselves in overcoming their problems and difficulties for planting fiber plant system. By having this study as a reference, new local growers can probably make a wise choice in choosing their crops for plantation.

5. References

[1] Panneerdhass, R., Gnanavelbabu, A. and Rajkumar, K. 2014. Mechanical properties of luffa fiber and ground nut reinforced epoxy polymer hybrid composites. Procedia Engineering, 2042-2051.

[2] Asim, M., Abdan, K., Jawaid, M., Nasir, M., Dashtizadeh, Z., Ishak, M.R. and Hoque, M.E. 2015. A review on pineapple leaves fibre and its composites. International Journal of Polymer Science, 1-16.

[3] Tanobe, O., A., V., Flores-Sahagun T., H., S., Amico, S., C., Graciela I., B. and Satyanarayana, K., G. 2014, Sponge gourd (Luffa cylindrical) reinforced polyester composites preparation and properties Defence Science Journal 64 (3): 273-280.

[4] Manikandaselvi, S., Vadivel, V. and Brindha, P. 2016. Review on Luffa acutangula L.: Ethnobotany, phytochemistry, nutritional value and pharmacological properties. International Journal of Current Pharmaceutical Review and Research, 7 (3), 151-155.

[5] Shendge, P., N. and Belemkar, S. 2018. Therapeutic potential of Luffa acutangula: A review on its traditional uses, phytochemistry, pharmacology and toxicological aspects. Frontier in Pharmacology, 9 (1177), 1-14. DOI: 10.3389/fphar.2018.01177

[6] Davis, J.M. 1994. Luffa sponge gourd production practices for temperate climate Hortscience 29(4):263–266.

[7] Md. Saiful Islam, Adriana Kovalcik, Mahbub Hasan, and Vijay Kumar Thakur. 2015. Natural fiber reinforced polymer composites. International Journal of Polymer Science, 1-2. DOI: org/10.1155/2015/813568

[8] Sujatha, D., Chithakari, R., Raghuvardhan, L., Prasad, B., Gulab Khan, R., Sadanandam, A. and Christopher, R. 2013. In Vitro plantlet regeneration and genetic transformation of sponge gourd (Luffa cylindrica L.). African Journal of Plant Science, 7 (6), 244-252.

[9] Obor, I., O. and Aluyor, E., O. 2009. Luffa cylindrica – An emerging cash crop. African Journal of Agricultural Research, 4 (8), 684-688.

[10] Ping-Lun Jiang, Mei-Yin Chien, Ming-Thau Sheu, Yi-You Huang, Meng-Hsun Chen, Ching-Hua Su and Der-Zen Liu. 2014. Dried fruit of the luffa sponge as a source of chitin for application as skin substitutes. BioMed Research International, 1-10. dx.doi.org/10.1155/2014/458287
[11] Hossain, M., F., Salam, M., A., Uddin, M., R., Pervez, Z. and Sarkar, M., A., R. 2002. A comparative study of direct seeding versus transplanting method on the yield of Aus rice. *Pakistan Journal of Agronomy*, 2 (3), 86-88.

[12] Medeiros, M., G., Neto, J., S., S., Oliveira, G., B., S., Torres, S., B. and Silveira, L., M. 2019. Physiological maturity of *Luffa cylindrica* (L.) Roem. Seeds. *Revista Ciencia Agronomica*, 50 (1), 76-82.

[13] Xie, Y., Liu, G., Li, Y. and Migliaccio, K. 2016. Luffa - an Asian vegetable emerging in Florida. *Uf/IFAS Extension*, 1-6. [http://edis.ifas.ufl.edu](http://edis.ifas.ufl.edu)

[14] Karthik, T. and Ganesan, P. 2015. Characterization and analysis of ridge gourd (Luffa acutangula) fibres and its potential application in sound insulation. *Journal of The Textile Institute*, 2-16. DOI: 10.1080/00405000.2015.1114792

[15] Almeida, A., L., F., S., Barreto, D., W., Calado, V. and Almeida, J., R., M. 2006. Effects of derivation on sponge gourd (Luffa cylindrica) Fibres. Polymers and Polymer Composites, 14 (1), 72-80.

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