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Misai Kucing plotting arrangement under solar PV panel and harvester machine efficiency – A comparative study

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Abstract
Orthosiphon stamineus, a member of the Lamiaceae, is a native plant to tropical Asia. Misai Kucing can be harvest four cycles per year after planting. In Malaysia, this plant has been planted under solar photovoltaic (PV) arrays in large scale area. Until today, the harvesting process of the shoot is done manually using regular hand cutters such as knife and scissors. It is difficult to harvest the shoots since there is limited space between the plant and the solar panels. By using machinery, the labor worker and overall cost can be reduced, and productivity and profitability can be increased. Prior to the harvesting machine development, a study on the plot arrangement of the Misai Kucing under PV panel is required. The objective of this study is to determine the best plot arrangement based on three parameters which are total polybag harvested, harvesting time required and distance covered by the machine under one PV panel. The results will be discussed in consideration with the efficiency aspect of the harvester machine. The result shows that the plot arrangement E which provide 4 polybags per row to be harvested at one time has the highest total polybag to time and distance ratio. This result provides efficiency for the harvester machine to be designed and developed.

Keywords: misai kucing, solar PV panel, harvester machine, plot arrangement, efficiency, time, polybag

Introduction

Orthosiphon stamineus (Figure 1), a member of the Lamiaceae, is a native plant to tropical Asia. Although it was first introduced to the European consumers as an herbal tea in the 20th century, this species only became popular, particularly in Indonesia and Malaysia in the last few decades It is commonly known as "Misai Kucing" in Malaysia and Singapore, "Kumis Kucing" in Indonesia or Java Tea in. Misai Kucing can be harvest four cycles per year after planting. O. stamineus is used for treating diseases such as rheumatism, diabetes, hypertension, tonsillitis, epilepsy, menstrual disorder, gonorrhea, syphilis, renal calculus, gallstone, urinary lithiasis, edema, eruptive fever, influenza, hepatitis, jaundice and biliary lithiasis(Awale *et al*., 2002).

Figure 1: Orthosiphon Stamineus

Hybrid Agric Voltaic (Figure 2) evokes the green ecological economy concept through inculcating herbal plots under solar photovoltaic (PV) arrays in large scale. This approach optimally utilizes the unused space under solar PV arrays despite the issues of radiation effect and extensive heat discharge through inculcating Misai Kucing as the sustainable high-value herbal plant (Othman *et al*., 2017).

Figure 2: Hybrid Agric Voltaic

Until today, the harvesting process of the shoot is done manually using regular hand cutters such as knife and scissors. It is difficult to harvest the shoots since there is limited space between the plant and the solar panels. By using a tool like a machine as shown in Figure 3, the labor worker can be reduced, productivity can be increased, the cost can be reduced, and the profit can be increased.

Prior to the harvesting machine development, a study on the plot arrangement of the Misai Kucing under PV panel is required to determine the most

optimized parameter that will be considered for the machine development. The objective of this study is to determine the best plot arrangement of Misai Kucing based on three parameters which are total polybag harvested, harvesting time required and distance covered by the machine under one PV panel. The results will be discussed in consideration with the efficiency aspect of the harvester machine.

Figure 3 Misai Kucing Harvester

Materials and methods

A twelve-series configured with 95WCEEG monocrystalline PV array has been installed in Universiti Putra Malaysia, Serdang, Malaysia at GPS coordinate of 2_5902000N: 101_4303000E as illustrated in Figure 2. The build-up area covers 8.64m^2 with a practical conversion efficiency of 17.05 percent at slanted tilt-angle of 7.60 facing 1600 south. The herbal plots are arranged with a few arrangement under PV foundation. The Java Tea plant growth process which covers pre and post herbal preparation is with flow segregation in 3 stages based on plant condition. Initially, the seedlings use fresh branches with small nodes from a mature plant at the herbal nursery. The polybags size is 12 cm x 12 cm and 80 percent filled with mix soils of top-soil, organic fertilizer, ash, sand and granulated stones. The mature period for Java Tea is approximately 2 months after deposition at PV site. Figure 1 shows the raw material in wet condition after washing and rinse before the oven drying and semi-fine grinding process. The operational costs and profits are achieved at a different sequence of harvesting period with specific increasing interest rates (Othman *et al*., 2014).

Results and discussion

Six plot arrangements of Misai Kucing under solar PV have been studied which comprised of three different plot arrangement layouts; 2-2 polybag (Figure 4 and 5), 3-3 polybag (Figure 6 and 7) and 3-3 polybag as shown in Figure 8 and 9. Each arrangement layout is plotted either in vertical and horizontal form. Space at the very left or right side of the polybags is left empty to allow the machine (Figure 3) with a motor, attached at the side of the machine, to pass through all polybags at the first cut.

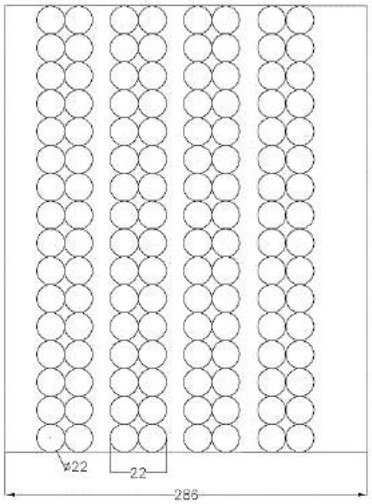

Figure 4 Plot arrangement A (2-2 polybag)

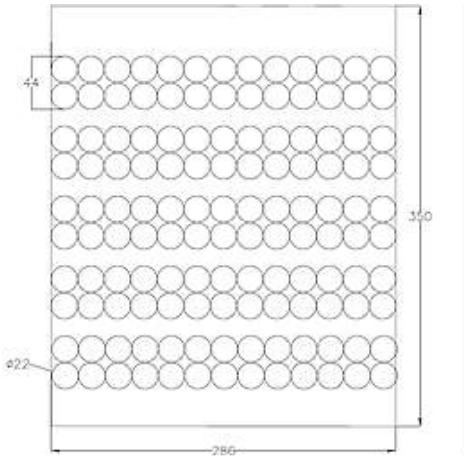

Figure 5 Plot arrangement B (2-2 polybag)

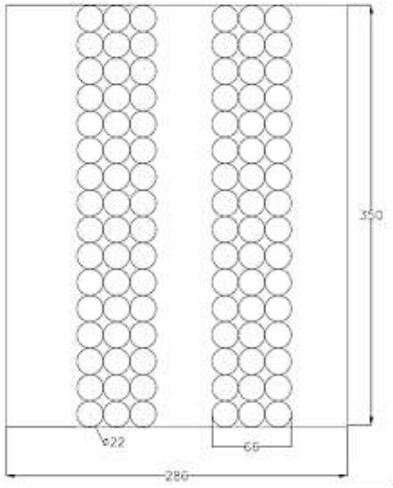

Figure 6 Plot arrangement C (3-3 polybag)

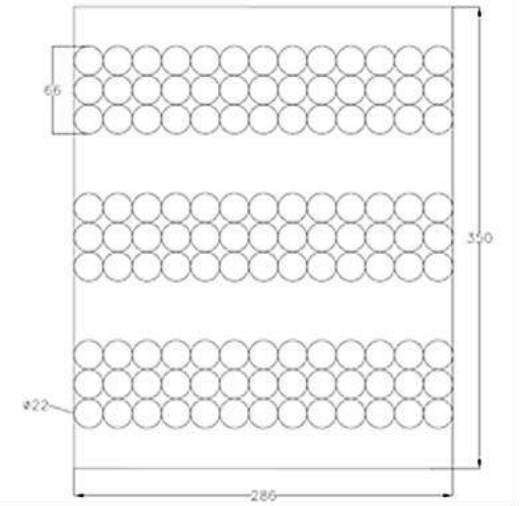

Figure 7: Plot arrangement D (3-3 polybag)

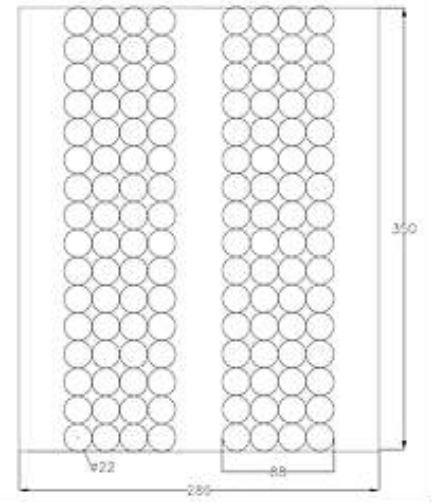

Figure 8: Plot arrangement E (4-4 polybag)

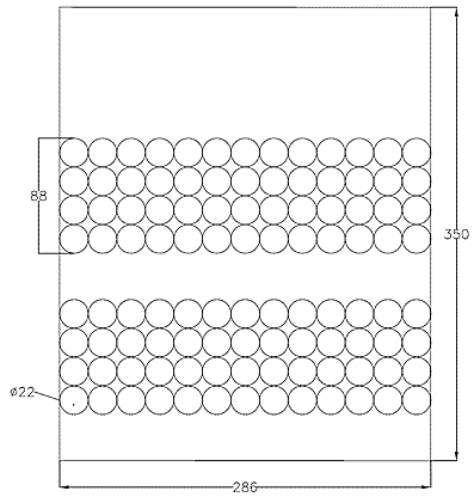

Figure 9: Plot arrangement F (4-4 polybag)

Table 1 shows results for three parameters including total polybag harvest, time requires, and distance cover for all plot arrangements. Plot arrangement B (2-2 polybag) offer the highest number of polybag that can be harvested, however, this arrangement requires the longest time and largest distance covered during harvesting. Plot arrangement E (4-4 polybag) shows a relatively high number of polybag can be harvested at the shortest amount of time and the distance covered by the machine is small. However, it is difficult to identify the optimum plot arrangement which provides the highest efficiency aspect.

Therefore, the ratio of total polybag to time and distance were calculated as shown in Table 2. The ratio of total polybag to time for plot arrangement E (4-4 polybag) is the highest which is 6.4. It means that such plot arrangement is able to allow the harvesting machine to harvest 6.4 polybags in a second. As compared to plot arrangement B, it can only offer 2.6 polybags to be harvested in one second.

Plot arrangement E (4-4 polybag) shows the highest number of total polybag to distance ratio which is 18.3. It means that for every meter that the machine covered, it can harvest a total of 18.3 polybags. From the result, it shows that plot arrangement E provide the most efficient arrangement as a guideline to design and develop the harvesting machine for Misai Kucing.

Table 1 : Different plot arrangements and their parameters

Parameter	Plot arrangement					
	A	**B**	**C**	**D**	**E**	**F**
Total polybag harvest	128	130	96	117	128	104
Time require (s)	40	50	30	20	20	20
Distance cover (m)	14	14.3	7	8.58	7	5.72

Table 2 : Ratio of total polybag to time and distance

Parameter	Plot arrangement					
	A	**B**	**C**	**D**	**E**	**F**
Total polybag to time ratio	3.2	2.6	3.2	5.85	6.4	5.2
Total polybag to distance ratio	9.1	9.1	13.7	13.6	18.3	18.2

Conclusions

Based on the results, it shows that plot arrangement E which provide 4 polybags per row to be harvested at one time has the highest total polybag to time and distance ratio. This result provides efficiency for the harvester machine to be designed and developed. Although plot arrangement E was found to be the most efficient arrangement, other parameters such as fabrication cost and handling effectiveness should be

taken into consideration before going further with the machine development.

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