

Tiller Size and Water Table Effects in Celery Growth on Floating Cultivation System

Pengaruh Ukuran Bibit dan Muka Air pada Pertumbuhan Seledri dengan Sistem Budidaya Terapung

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ABSTRAK

Rawa lebak merupakan salah satu lahan suboptimal dengan potensi luas lahannya yang dapat menjadi alternatif untuk lahan pertanian, namun terdapat beberapa kendala. Penelitian ini bertujuan untuk meningkatkan diversifikasi tanaman sayuran dalam pemanfaatan lahan rawa lebak, dengan sistem budidaya secara terapung. Penelitian dilaksanakan di Jakabaring (104°46'4" E; 3°01'35" S) Palembang pada bulan november sampai desember 2019. Penelitian menggunakan metode Rancangan Petak Terbagi (*Split Plot*)-Rancangan Acak Lengkap (RAL) yang terdiri dari 2 faktor yaitu petak utama dan petak bagian. Faktor petak utama adalah kedalaman rakit terhadap muka air yang terdiri dari R₁ (muka air 1 cm di atas rakit), R₅ (muka air 5 cm di atas rakit) dan R₁₀ (muka air 10 cm di atas rakit). Faktor petak bagian adalah ukuran bibit seledri yang terdiri dari B₁ (ukuran bibit besar), B₂ (ukuran bibit kecil). Kombinasi tiap perlakuan terdiri dari 5 ulangan. Hasil penelitian menunjukkan berpengaruh tidak nyata pada kombinasi semua parameter pengamatan (tinggi tanaman, luas daun, pertambahan jumlah tangkai, panjang akar, berat segar dan kering akar serta berat segar dan berat akar tangkai) tetapi perlakuan muka air berpengaruh nyata pada parameter panjang akar. Kesimpulan, budidaya terapung seledri dari bibit anakan induk dapat menjadi alternatif untuk meningkatkan aktifitas budidaya dengan memperpendek masa tanam sehingga meningkatkan diversifikasi tanaman di rawa lebak.

Kata kunci: *Apium graveolens* L., diversifikasi sayuran, budidaya terapung

ABSTRACT

Riparian wetland is highly available and potential suboptimal lands for an alternative solution in extending agricultural activity, but several constrains need to be resolved. The objective of this study was to improve the diversification of vegetables for increasing riparian wetland with utilizing floating cultivation system. This study was conducted From November until December 2019 in Jakabaring (104°46'4" E; 3°01'35" S) Palembang. The design of experiments used in this study was arranged in split plot-completely randomized design with 2 factors (main plot and sub-plot). Main plot was the height of water table,

namely: R₁ (1 cm upper raft surface), R₅ (5 cm upper raft surface), and R₁₀ (10 cm upper raft surface). Sub-plot was the size of celery tiller, i.e., B₁ (big size) and B₂ (small size). Each combination treatment consisted of five replication. Results showed that there was no any significant effect on water table and tiller size combination treatments in all observed variables, such as: plant height, leaf area, number of petioles, root length, fresh weight, and dry weight of shoot and roots. But, root length was significant different in water table treatment. Therefore, cultivated celery using floating culture system from tiller of parent plants can be an alternative to increase agriculture activity by shortening the planting period to increase vegetable diversification in riparian wetland.

Keywords: *Apium graveolens* L., vegetable diversification, floating culture

INTRODUCTION

Riparian wetland is highly available and potential suboptimal lands for an alternative solution in extending agricultural activity, but several constrains occurred. Riparian wetland is dominant ecosystem in Sumatera (8,41 million hectares), Papua (7,49 million hectares), and Kalimantan (6,99 million hectares) (Arsyad *et al.* 2014). Some constrains for agriculture activity in riparian wetland as marginal land are: low soil fertility, various typology, and unpredictable period and depth of flooding (Nasir *et al.*, 2015). Intensity and productivity of agriculture in riparian wetland is still below its potency due to conventional cultivation system practice (Simatupang and Rina, 2019). Implementation of suitable technology innovation for specific land characteristic is a promising solution to solve the problems in riparian wetland.

Floating cultivation system is an applicative adaptive form of suitable solution for flooding that occurs every year. Floating system maintains plants growth during flooding (Hasbi *et al.*, 2017). One of the advantages of floating cultivation system is lessen daily crop maintenance activity, i.e., watering the plants. Water is continuously available as long as the bottom of media exposed to water surface (Siaga *et al.*, 2018). Cultivation of organic vegetables on floating system is possible and could produce relatively similar yield with direct plants cultivation in land (Marlina and Aminah, 2015). Vegetable cultivation system had been reported for

spinach (Syafrullah, 2014), chili (Siaga *et al.*, 2017), red lettuce (Syafrullah *et al.*, 2018), green eggplant (Jaya *et al.*, 2019), green nut, water spinach, and green mustard (Lituañas *et al.*, 2019). The preference of local farmers in riparian wetland for vegetable cultivation is high. Widuri *et al.* (2016) reported that 55% farmers in 5 villages in Pemulutan were interested in vegetable cultivation. Thus, diversification to various vegetables is suitable to be applied in riparian wetland.

Celery (*Apium graveolens* L.) is an important spice vegetable plants and always available for the whole year (Adawiyah and Afa, 2018). Celery is adaptable to many kind of cuisine and usually utilized in small amount but important spice in several foods. High demand of fresh celery in Indonesia is still unfulfilled (Embarsari *et al.*, 2015). Vegetative propagation from tillers of parent plant might increase celery production. Azmi *et al.* (2016) reported that variety and tuber size of shallot significantly affected observed growth variables. The effects of tiller size and water table in celery growth on floating cultivation system is necessary to know. This study aimed to increase vegetable diversification for riparian wetland use.

MATERIALS AND METHODS

This study conducted in Jakabaring (104°46'4" E; 3°01'35" S) Palembang, from November to December 2019. The design of experiments used in this study was arranged in split plot-completely randomized design with 2 factors (main

plot and sub-plot). Main plot was the height of water table, namely: R₁ (1 cm upper raft surface), R₅ (5 cm upper raft surface), and R₁₀ (10 cm upper raft surface). Sub-plot was the size of celery tiller, i.e., B₁ (big size) and B₂ (small size). Each combination treatment consisted of five replication. The calculated F-value generated from the analysis of variance (ANOVA) was compared to values of F-table at $p \leq 0.05$ and $p \leq 0.01$ for justifying significant effects of the treatments. Furthermore, if the treatment effect was significant on any measured traits, the least significant difference (LSD) test was conducted.

Material used were celery tillers, soil, manure, sand, and NPK fertilizer. Tools used were floating raft, pot, and analytic scale. The steps of this study were media preparation (mixed of soil, manure, and sand (1:1:1)), separation of tillers from parent plant based on its size treatment and transplanted to pot, arrangement of plants according to the water table treatments on floating raft inside the trial pool, application basic fertilizer application (5 g NPK per pot), manual weeds control, and harvest. Observed variables were plant height, leaf area, number of petioles, fresh and dry

weight of shoot, fresh and dry weight of root, and root length.

RESULTS

Results showed that there was no any significant effect of both water table and tiller size combination treatments on all observed variables, such as: plant height, leaf area, number of petioles, root length, fresh and dry weight of root and shoot and moreover, the root length was significantly different in water table treatment (Table 1). The highest celery obtained from the plants on 1 cm upper raft surface water table transplanted from big tiller (Figure 1). Big tiller size had larger leaf area than small tiller size (Figure 2). The highest increase of petioles number found in 10 cm upper raft surface water table from big size tiller (R₁₀B₁) (Figure 3). Shoot fresh and dry weight were higher in 1 cm upper raft surface (R₁) compared to other water table treatments (Figure 4). Root fresh weight reduced as water table increase (Figure 5). Root length was similar in all of treatments, but the highest root growth showed in R₁ (Figure 6).

Table 1. Water table and tiller size application effects in celery floating culture

Parameter	F Value		
	Water Table (WT)	Tiller Size (TS)	WT x TS
Plant height	0.59 ^{ns}	3.17 ^{ns}	0.15 ^{ns}
Leaf Area	0.26 ^{ns}	4.15 ^{ns}	0.61 ^{ns}
Numbers Of Petiole	1.08 ^{ns}	0.01 ^{ns}	0.64 ^{ns}
Shoot FW	1.37 ^{ns}	0.27 ^{ns}	0.70 ^{ns}
Shoot DW	1.21 ^{ns}	0.01 ^{ns}	0.46 ^{ns}
Root FW	0.55 ^{ns}	0.07 ^{ns}	0.76 ^{ns}
Root DW	0.48 ^{ns}	0.08 ^{ns}	0.96 ^{ns}
Root Length	5.01 [*]	3.23 ^{ns}	0.79 ^{ns}

Note: ^{ns} are not significantly different, ^{*}significantly different at $p \leq 0.05$)

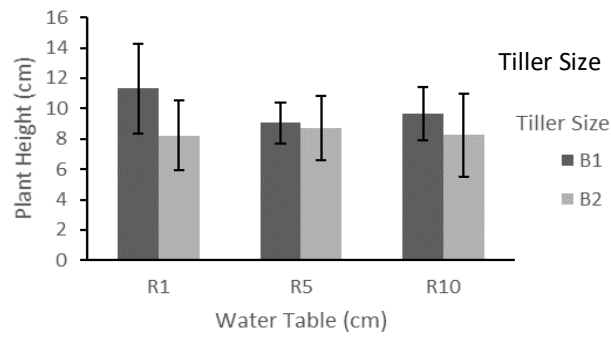


Figure 1. Plant height in different water table and tiller size of celery

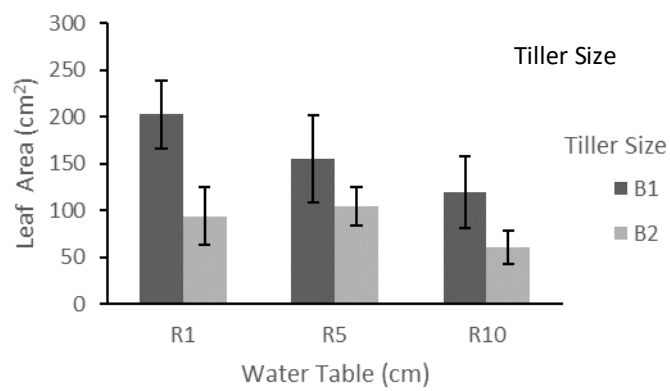


Figure 2. Leaf area in different water table and tiller size of celery

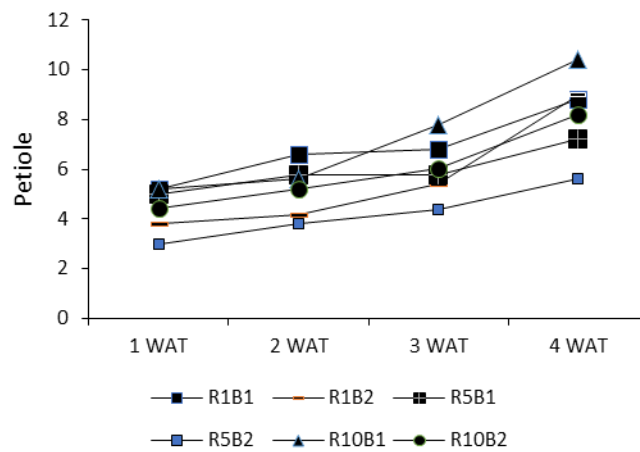


Figure 3. Increase number of petiole in different water table and tiller size of celery

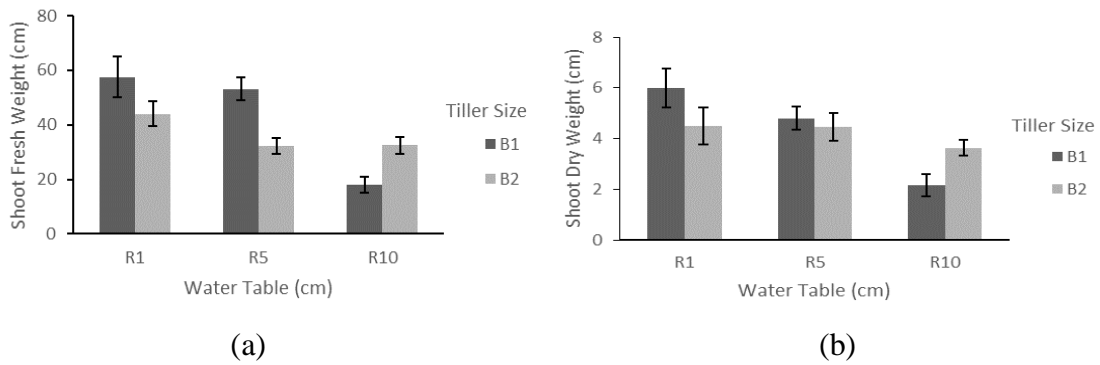


Figure 4. Shoot fresh weight (a) and dry weight (b) in different water table and tiller size of celery

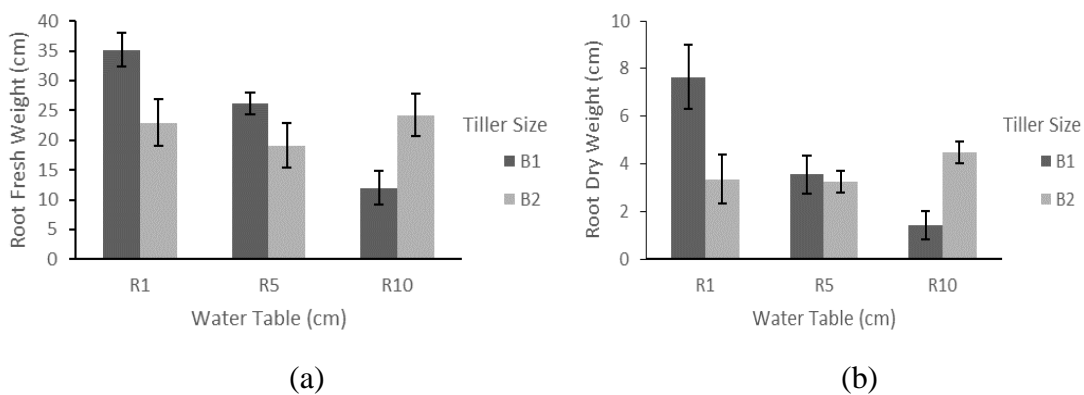


Figure 5. Root fresh weight (a) and dry weight (b) in different water table and tiller size of celery

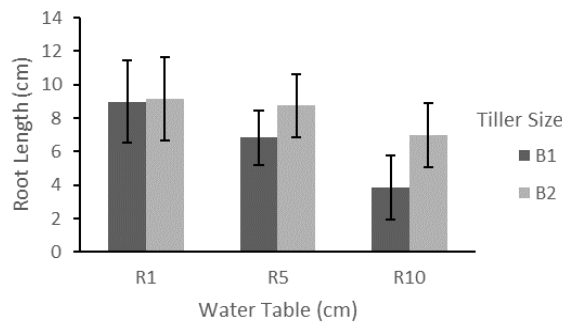


Figure 6. Root length in different water table and tiller size of celery

DISCUSSION

Results showed that plants in 1 cm upper raft surface water table performed better than those planted in 5 cm or 10 cm for all observed variables. This result was similar with Siaga *et al.* (2018) that the best growth obtained by plants grew on a little interface between water surface with growing media. This condition allows water diffusion to

soil media. The more intensive of water supply, the higher rate of plant growth and development. However, excess water causes stress in plant (Kusumawati *et al.*, 2016). Excess water stress occurs when water table is too high and damage root system. Waterlogging decreased plant height in chili associated with the aerobic changed into anaerobic condition, decrease O₂ concentration and increase CO₂

concentration in rhizosphere. These conditions disturb root metabolism and reduce nutrients absorption (Safrizal *et al.*, 2008). Plant respond to stress condition including leaf chlorosis, yellowing, rolling, and fall out. Wilted leaf at the beginning of stress related to stomata (Pratama and Purnamaningsih, 2019). Therefore, its affect growth parameter in this study. There were more petiole number but contrast with leaf area in more deeper water table treatment. it means, the deeper water table treatment, have smaller leaf than other treatment and might not fully work in photosynthesis. Light interception, plant CO₂ fixation and photosynthesis were determined by leaf area which influences dry matter production of plants (Liu and Stutzel, 2002). As leaf vegetable, celery growth of leaf area really important to maintain because its make more marketable yield.

Result show that root length of celery were significantly different in water table treatment (Table 2). The deeper water table treatment had shorter length of root due to water limit in basal media of plants that induce by oxygen deficiency. When root system is disturbed, transportation and metabolism of nutrients to shoot also disturbed too. This study revealed that higher water table reduce fresh and dry weight, and length of root. Those reduction decreased nutrients absorption and affected leaf area. Reduction in leaf area slowed down photosynthesis process and decrease shoot fresh weight. As (Pratama and Purnamaningsih, 2019) stated that plant metabolism and fresh weight are affected by water content in plant tissue, nutrient, and metabolism output. Reduce in dry weight might due to reduction in leaf area since chlorophyll as photosynthetic organelle and primer metabolism. Celery petiole is a part of plant being harvest and will surely affect the yield. Therefore, celery cultivation in floating system does not need high water table or will cause several reductions in plant growth variables as result of stress. In addition, watery is not necessary.

Table 2. Water table effects on root length of floating culture celery

WT Treatment (cm)	Root Length (cm)
R ₁ (1 cm)	9.06 a
R ₅ (5 cm)	7.79 ab
R ₁₀ (10 cm)	5.42 b
LSD	2.54

Note: Means followed by different letter were significantly different based on LSD test at $p \leq 0.05$

Tiller size was not significantly different, but bigger size of tiller had higher result. As (Darma *et al.*, 2015) stated that the big size of tuber showed better growth in shallot compared to small size as indicated by plant height, leaf area, and number of tillers. Tuber consisted of higher bulbous and the ability to grow is relatively faster. In addition, bigger tiller has wider root system and number of root growth is higher. Nutrients are sufficiently absorbed to support plant growth (Uke *et al.*, 2015). In this study, tiller size did not affect all observed variables. We assumed that tuber in shallot is a harvested organ, while tuber in celery only acts as root and did not affect the yield directly. Despite the resulted in deeper water table treatment, celery can still grow. Celery should be ready for harvest at 85 to 120 days after transplanting depending on the variety (Yommi *et al.*, 2013). Therefore, cultivated celery from tiller parents can be an alternative to cultivated in riparian wetland to increase agriculture activity there by shortening the planting period. Because, it just needs 4 WAT (Weeks After Transplanting) to be harvested. And also, because the tiller size different not affect significantly to next plants life, any size tiller size can be chosen for cultivation.

CONCLUSION

Cultivated celery using floating culture system with 1 cm water table from tiller of parent plants can be an alternative to increase agriculture activity by shortening the planting period to increase vegetable diversification in riparian wetland.

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