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Effects of Water Table, Population Density and Transplanting Time on Vegetative Growth of Black Sticky Rice at Floating Seedbed Method

Pengaruh Tinggi Muka Air, Kerapatan Populasi dan Waktu Transplanting terhadap Pertumbuhan Vegetatif Ketan Hitam dengan Metode Persemaian Terapung

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ABSTRAK

Pengembangan budidaya beras ketan hitam di Sumatera Selatan masih jarang dilakukan oleh petani. Penelitian bertujuan untuk mengetahui pengaruh kejenuhan media dan kerapatan populasi terhadap pertumbuhan bibit selama pembibitan menggunakan persemaian terapung, serta pengaruh waktu transplanting terhadap pertumbuhan beras ketan hitam varietas toraja pada fase vegetatif. Penelitian dimulai pada bulan Mei 2018 di Palembang. Beras ketan hitam yang digunakan pada penelitian ini adalah varietas toraja. Rakit yang digunakan dibuat dari botol plastik 1,5 L yang dirangkai mencapai ukuran 2x1 meter. Penelitian dilakukan dengan 2 fase, fase pertama melihat efek kejenuhan media dan kerapatan populasi pada pertumbuhan bibit, fase kedua melihat efek waktu transplanting terhadap pertumbuhan selama fase vegetatif. Secara statika, hasil menunjukan bahwa kejenuhan media dan kerapatan populasi bibit berpengaruh secara signifikan terhadap panjang akar bibit sedangkan waktu transplanting 14 HSS memberikan efek terhadap panjang daun, lebar daun dan luas daun.

Kata kunci: beras ketan hitam, metode terapung, kejenuhan media, kerapatan populasi, persemaian, waktu transplanting

ABSTRACT

Study on black sticky rice cultivation in South Sumatera is seldom carry out. The objective of this study was to evaluate the effect of water table and population density on the growth of rice during seedling preparation at floating seedbed; furthermore, this study aimed to evaluate the effect of transplanting time on vegetative growth of black sticky rice. The research was started in May 2018 in Palembang. Black sticky variety used in this research was Toraja variety. The raft used is made from 1,5 l plastic bottles which are arranged to reach 2x1 meters in size. This study was conducted by two stages. The first stage was for water table and population density treatments laid on split plot design. The second stage was for transplanting time utilizing completely randomized factorial design. Statistically, results showed water table and population density significantly influensced

root length of black sticky rice and transplanting time 14 DAS haad an effect on the leaf length , leaf width and leaf area.

Key words: black sticky rice, floating system, population density, seedling preparation, transplanting time

INTRODUCTION

Study on black sticky rice cultivation in South Sumatera is seldom carry out. Morphologi and anatomy of black sticky rice same as like black rice in general. High plant crown, long harvesting age, and low productivity are inhibiting factors for lack rice development. The height of black rice reaches 160 cm with harvesting age up to 157 days for producing 7,5 ton/ha (Azmi *et al*., 2017) and susceptible to environmental change had caused a little interest for farmers to cultivate it. However, black rice contains high amylose (9,05%) (Febriana *et al*., 2014). Black rice has sticky structure (Adhi *et al*., 2017).

Sumatera selatan dominated with riparian wetland ecosystem. Yet, unpredictable flooding occurrence unable the farmers to utilize the paddy field for more than once plant cultivation per year (Guwat *et al.*, 2015). High water level submerges rice seeds and decrease the ability of rice to grow optimally (Siaga *et al*., 2016). In addition, unpredictable water level increase the risk of waterlogging and submergence stress during vegetative stage of rice (Siaga *et al.*, 2016). Seedling preparation on floating seedbed is an alternative solution to avoid high risk of submergence. Floating system allows farmers to utilize flooding period for early seedling preparation and accelerate planting time.

Floating system conduct on a raft with decomposed aquatic weeds biomass as growing media (Lindiana *et al*., 2016). Seedling growth usually affect by population density especially on competition for absorbing nutrients from growing media (Pithaloka *et al*., 2015). Higher density indicates higher plant population. Competition on absorbing sunlight, water, and nutrient happened when density is too high. In contrary, low density indicates low population with lower intensity of competition as well (Fatchullah, 2017). The precise transplanting time is necessary to anticipate the reduction of root development which is usually stop growing at 42 DAS (Kuniasari *et al.*, 2018).

Optimum time for rice transplanting is 15 DAS (Napisah, 2014). Younger seedling age is more adaptable to environment and deeper root system that higher resistance to fall and drought stress, and might absorb nutrient effectively (Anggraini, 2013). Thus, this study aimed to understand the effect of water table, population density, and precise transplanting time for black sticky rice vegetative growth.

MATERIALS AND METHODS

Seedling preparation

Seedling was prepared on 3 rafts (2x1 meter) constructed from 1.5 L size mineral water bottles. Each raft represented different water table (mainplot) and wasdivided into 3 parts per each for population density treatments (sub-plot). This study was arranged base on split plot design with 2 factor and 3 treatments per each. The first factor (mainplot) were: R_1 = 0.0 mm (in contact with water surface); R_2 = 7.5mm (partial saturated); R_3 = 15 mm (fully saturated). The second factor (sub-plot) were D_1 = 0,25 kg/m^2; D_2 = 0,50 kg/m^2; D_3 = 0,75 kg/m^2.

Transplanting

Seedlings were transplanted at 14 DAS, 21 DAS, and 28 DAS.

DataAnalysis

Statistical analysis for evaluating treatment's effect on measured variables were carried out using the Analysis of Variance (ANOVA). Differences between

means were tested using the Least Significant Difference (LSD) at $p < 0.05$.

RESULTS AND DISCUSSION

Seedling Preparation

Seedling Height and Leaf Variables

The result of analysis of variance showed that water table and population density were not significantly affected the seedling height but it was increasing every week (Figure 1 a). The highest seedling showed by R_1D_3 treatment and the lowest height found in R_2D_2. The longest leaf length obtained byR_2D_1, while the shortest was R_2D_2 (Figure 1 b). For leaf width, the highest average found in $R_1D_1$and lowest in R_3D_1 (Figure 1 c). The highest leaf area showed by R_1D_1 and smallest at R_2D_2 (Figure 1 d). Significant effect of water table found in number of leaves. The highest number of leaves obtained by seedlings treated with R3 (Figure 1 e).

Seedling Root Length

Based on analysis of variance, water table and population density were significantly affected root length. The longest root length average showed by R_1D_1 treatment and the shortest at R_1D_3 treatment (Figure 1 f).

Seedling Density, Fresh Weight, and Dry Weight

Based on analysis of variance, population density significantly affected seedling density, and its fresh and dry weight. For those three variables, treatment density 0,75kg/m^2 was significantly different with 0,25kg/m^2 and 0,50 kg/m^2. Water table was significantly affected seedling fresh weight (Table 1).

Plant Height and Leaf Area after Transplanting

The average of plant height was affected by transplanting time (Table 3). 14 DASwas significantly different with 21 DAS and 28 DAS. Transplanting time 14 DAS showed highest value on leaf area at 7 WAT until 10 WAT (Table 2).

Number of Leaves and Number of Tillers after Transplanting

The result of anaysis of variance showed that the effect of interaction between water table, population density, and transplanting time were significant on number of leaves variable(Table 4). As for number of leaves, W_1 treatment was significantly different with W_2 and W_3. Meanwhile, result of analysis of variance exhibited that interaction of water table and population ddensity showed R_3D_1 was significantly different with R_1D_2, R_2D_2, R_2D_3, and R_3D_2. Result also indicated that number of tillers effected by transplanting time showed significant difference of W_1 compared to W_2 and W_3(Table 5).

Leaf SPAD

Leaf SPAD was measured using chlorophyll meter (Konica Minolta SPAD-502 Plus). Result of analysis of variance showed that transplanting time was significantly affected leaf SPAD. At 5 weeks after transplanting 5WAT, treatment 14 DAS significantly different with 21 DASand 28 DASbut at 8 WAT, 28 DASwas significantly different with 14 DASand 21 DAS (Table 6). Figure 1 a-1 f explained that the highest number of seedling height, leaf length, leaf width, leaf area, and number of leaves dominantly obtained by R_1 treatment. It was reasonable sincein R_1, media was not saturated by water and oxygen was still available. This condition allowed rice root to grow and absorb nutrient well and support the better growth. D_1 treated with low density resulted lower intensity of competition.

Plants whose roots submerged has shorter roots because water inhibits root growth.Seeds with high population density make it difficult for roots to grow. Seeds with high population density make it difficult for roots to grow.

Table 1. The effects of water table and population density on seedling density, fresh weight, and dry weight of black sticky rice seedling prepared on floating seedbed

Density (kg/m^2)	Average		
	Seedling Density (g/cm²)	Fresh Weight (g)	Dry Weight (g)
0.25 kg/m^2	99.33 $_a$	0.182$_a$	0.039 $_a$
0.50 kg/m^2	184.00 $_b$	0.386$_b$	0.069 $_b$
0.75 kg/m^2	237.33 $_c$	0.569$_c$	0.116$_c$
LSD 5%	29.70	10.74	2.35
Water Table (mm)			
15 mm	181.47	0.392$_b$	0.072
7.5 mm	175.13	0.323$_a$	0.074
0.0 mm	164.07	0.422$_b$	0.080
LSD 5%		4.28	

Means followed with the same letters within rows are not significantly different based on the LSD at $p < 0.05$

Table 2. The effect of transplanting time on leaf area of black sticky rice's leaf

Transplanting Time	Leaf Area (cm^2)				
	7 WAT	8 WAT	9 WAT	10 WAT	11 WAT
14 DAS	50.16 $_c$	53.91 $_b$	60.80	71.19 $_b$	70.62
21 DAS	43.38 $_b$	52.21 $_b$	59.61	64.58 $_a$	68.05
28 DAS	36.10 $_a$	48.50 $_a$	58.84	70.43 $_b$	71.37
LSD 5%	3.24	3.00		3.33	

Means followed with the same letters within rows are not significantly different based on the LSD at $p < 0.05$

Table 3. Significantly different of height of black sticky rice after transplanting time

Treatment	Height (cm^2)					
	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT	11 WAT
14 DAS	65.65 $_a$	74.85 $_c$	83.32 $_c$	89.21 $_c$	98.55 $_b$	104.03 $_c$
21 DAS	52.28 $_b$	67.35 $_b$	77.68 $_b$	86.68 $_b$	92.29 $_a$	98.29 $_b$
28 DAS	37.32 $_a$	53.37 $_a$	68.37 $_a$	83.48 $_a$	91.11 $_a$	96.09 $_a$
BNT 5%	1,82	1,79	2,31	1,93	1,89	2,09

Means followed with the same letters within rows are not significantly different based on theLSD at $p < 0.05$

Tabel 4. Significantly different of number of leaves after transplanting time

Treatment	Number of Leaves					
	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT	11 WAT
14 DAS	102.92 $_c$	126.78 $_c$	126.18 $_c$	125.85 $_c$	127.70 $_c$	97.00
21 DAS	55.33 $_b$	90.00 $_b$	101.93 $_b$	107.48 $_b$	120.22 $_b$	94.55
28 DAS	27.56 $_a$	48.44$_a$	81.89 $_a$	89.15$_a$	102.33 $_a$	93.11
BNT 5%	4.9	6.7	6.68	6.06	4.53	

Means followed with the same letters within rows are not significantly different based on theLSD at $p < 0.05$

Table 5. Number of tillers after transplanting time from 6 WAT until 11 WAT

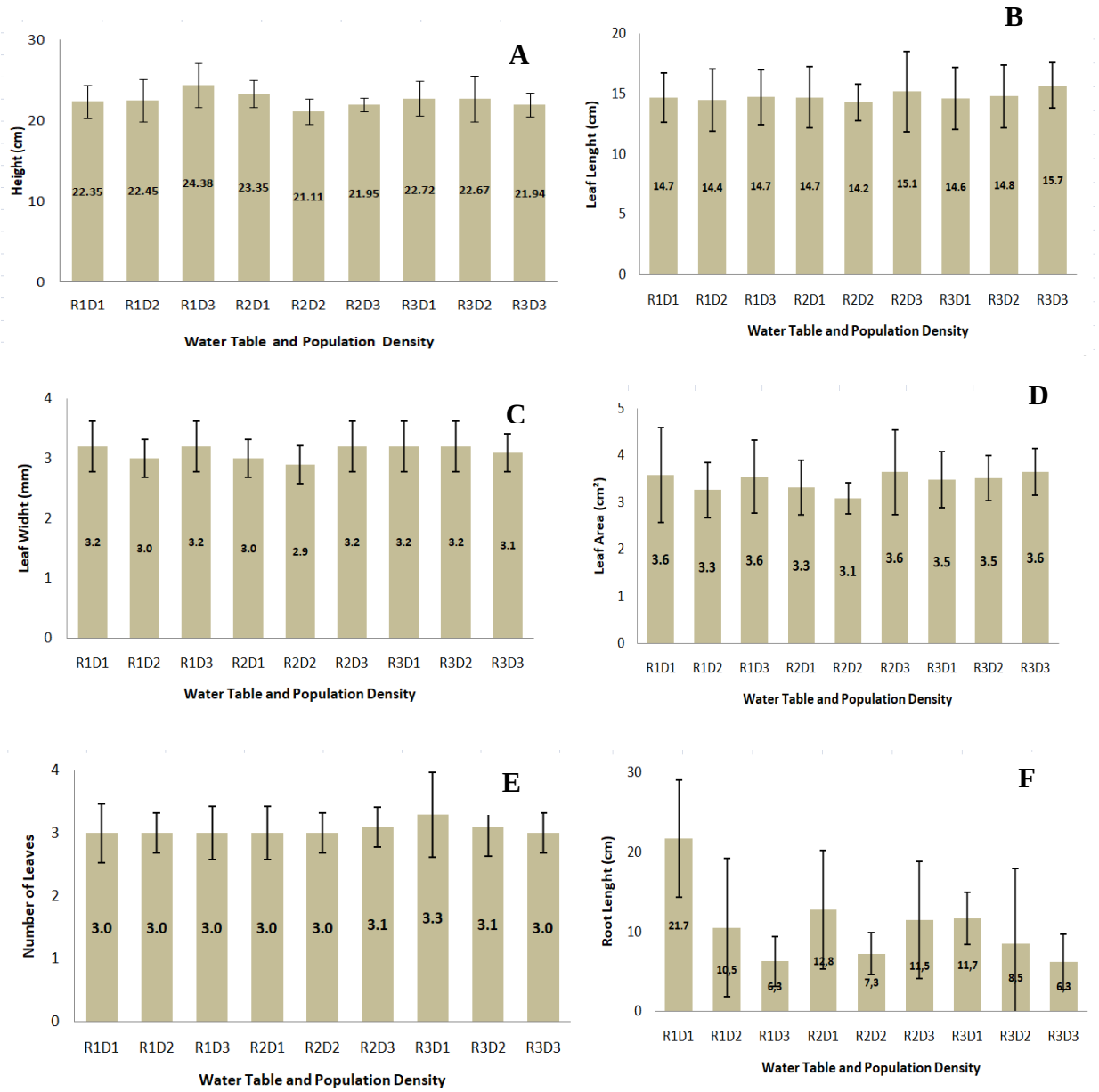
Treatment	Number of Tillers					
	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT	11 WAT
14 DAS	34.37 $_c$	43.33 $_c$	42.18 $_c$	42.51 $_c$	43.62 $_c$	32.14
21 DAS	18.44 $_b$	30.04 $_b$	34.48 $_b$	35.48 $_b$	39.96 $_b$	31.88
28 DAS	9.19$_a$	16.37 $_a$	27.30 $_a$	30.37 $_a$	34.37 $_a$	32.25
BNT 5%	1.7	2.15	2.39	2.12	1.65	

Means followed with the same letters within rows are not significantly different based on the LSD at $p < 0.05$

Table 6. The effect of transplanting time on leaf SPAD

Transplanting Time	SPAD	
	35 DAS	56 DAS
14 DAS	40.14 $_{c}$	33.50 $_{a}$
21 DAS	36.51 $_{b}$	37.76 $_{b}$
28 DAS	22.89 $_{a}$	40.18 $_{c}$
LSD 5%	2.00	1.00

Means followed with the same letters within rows are not significantly different based on the LSD at $p < 0.05$



Note: R is treatment of water table symbol; 15 mm (R1); 7.5 mm (R2), 0.0 mm (R3), D is treatment of density population symbol; 0.25 kg kg/m^2 D1); 0.50 kg/m^2 (D2); 0.75 kg/m^2 (D3)

Figure 1.The effects of water table and population density on height (a), leaf length (b), leaf width (c), leaf area (d), number of leaves, and root length (f) of black sticky rice seedlings at floating seedbed 4 WAT

Spacing density between one seedling and another causes root damage during seedling during transplanting (Usman *et al.*, 2014). The optimum seed density (not too dense) provides good growth because it utilizes more sunlight and nutrients (Ikhwani*et al.*, 2013). D3 has a higher fresh weight due to having more seeds. Overall dry weight is affected by elongation of stems and carbohydrates. According to Gribaldi and Nurlaili (2016) immersion stress affected dry weight of plants per clump.Based on (Erungan *et al*., 2014), rice transplanted at 10 DAS show the highest plant height every week. Young seedling (<15 DAS) have better adaptation ability with new environment after transplanting and utilize nutrient well. Transplanting time at 14 DAS (W1) significantly affected the length, width and area of leaf. Arifet.al., (2014) stated that the low leaf area due too late transplanting time affected by several factors, such as stress due to movement shocks when transplanting. Thus, transplanting at 15 DAS is best for providing the highest vegetative growth including length, width, and area of leaf, and producing higher yield compared to 20 days after seedling (Napisah, 2014).

Number of leaves and number of tillers (Table 4 and 5) in treatment W_1 (14 DAS) was significantly different to other treatments since the age of seedlings affected the number of tillers per hill and number of leaves. Transplanting at 14 DAS resulted in more leaves and higher number of tillers due to a longer vegetative stageto increase number of leaves and number of tillers continuously until 7 WAS. According to the study of Jalil *et al*. (2015), it was proven that transplanting at 15 DAS affected the number of tillers and panicle length. Transplanting at 10 WAS, increment number of tillers because plant starts entering the generative stage. Khakim *et.al.* (2015) revealed that the number of tillers will decrease in each plant family due to physiological death after the maximum number of tillers is reached. Tillers that are unable to compete in getting nutrients or other growth factors willalso die.The number of leaves and number of tillers were also influenced by transplanting time. According to Kuniasari *et al.* (2018) rice seedling transplants at 12 DAS rice seedlings produces the highest number of tillers compared to those transplanted at 24 DAS. Rice transplants at the olderage have less ability to form high number of tillers. The number of tillers is related to the period ofphyllochron formation.

Strategy for achieving long phyllochron formation period is by transplanting the seedlings at a young age (Sumardi *et al*., 2003).The longer the age of the seedlings, the less the number of phyllochron produces.Leaf SPAD at 56 DAS of plants treated with W_1 was significantly different (Table 6), it was in associated with W1 leaf area (Table 2). Leaf area affects the amount of SPAD. According to Haryanti (2014) larger and thinner leaves with larger size of stomata, and too high light intensity can reduce the rate of photosynthesis due to the fast-acting chlorophyll photooxidation which damaging chlorophyll.

CONCLUSION

Water level 0.0 mm and 25 kg/ha density resulted the best seedling growth such as leaf width, leaf area and root length. After transplanting, plants transplanted at 14 DAS provided better vegetative growth and a higher number of tillers than 21 DAS and 28 DAS.

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