

Investigation of the Factors Affecting On the Growth and Development Capacity of Melaleuca Leucadendra and Melaleuca Cajuputi in Semi-Flooded Area in Son La Hydropower

Tran Thi Pha¹, Tran Van Dien¹, Dam Xuan Van¹, Van Huu Tap²

¹Faculty of Environment, Thai Nguyen University of Agriculture and Forestry, Viet Nam

²Faculty of Environment and Earth Science, Thai Nguyen University of Sciences, Viet Nam

Abstract: Research on the cultivation solutions and flood level that had enormous effects on the growth and development capacity of two kinds of melaleuca in semi-flooded area in Son La Hydropower. Fertilizer method had effect on the growth and development capacity of two kinds of melaleuca, the most appropriate formula of two kinds of melaleuca is Formula 3 (60N + 30P2O5 + 30K2O). Plant density had large effect on the growth and development capacity of melaleuca. For Melaleuca leucadendra, it should be grown in the density from 6666 trees per hectare to 10000 trees/ha. For Melaleuca cajuputi, this tree should be grown in the density from 10000 trees/ha to 20000 trees/ha. About the flooded depth for Melaleuca leucadendra, it is suitable to grow in the flooded depth interval from 0 to 6m. Melaleuca cajuputi is suitable to grow in the flooded depth interval from 0 to 4m. Furthermore, this experiment help confirm the growth and development capacity of Melaleuca leucadendra is suitable for semi-flooded area in Son La hydropower rather than Melaleuca cajuputi, from 0.6 to 1 time.

[6] Introduction

Melaleuca belongs to Sim's family, it is a fast growing plant and it has the ability in order to adapt to wetland areas, low-nutrient soils, alkaline soils, low tropical region. Two kinds of melaleuca have been studied and widely cultivated in semi-flooded area that is Melaleuca leucadendra and Melaleuca cajuputi. Most of Melaleuca Leucadendra grow naturally on the flat and gentle terrain, particularly in rivers, coastal plains or swamps, seasonally flooded wetlands. In our country, Melaleuca cajuputi is naturally distributed in lowland areas that cover by water, flooded with alum in peat, clay and salty soils. These soils formed from sediment in alluvial river and sea in the South, mostly in Kien Giang, An Giang, etc. In the North, scientists have initially studied about the cultivation of Melaleuca forests on semi-flooded area such as Thac Ba hydropower, Tuyen Quang hydropower, Hoa Binh hydropower, Son La hydropower territory is about 200km from

Muong La district, Son La province to Muong Lay district, Dien Bien province. The reservoir submerged about 23,000ha of natural land, including 10,000ha of semi-flooded land. The above situation requires solutions to exploit semi-submerged land for the best benefit, while improving the ecological environment in this area is extremely necessary. The solution currently accepted by many scientists is Melaleuca planting, regenerate to forest in form of melaleuca forest from the highest water level to the hillsides in the basin of Son La hydropower reservoir.

[7] Materials And Methods

2.1. Materials

Materials: Melaleuca leucadendra and Melaleuca cajuputi

2.2. Methods

2.2.1. Experimental arrangement

- Experiment 1: Effect of fertilizer on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower:
 - + Treatment 1: No fertilizer (control experiment)
 - + Treatment 2: 40 N + 10 P2O5 + 10 K2O;
 - + Treatment 3: 60 N + 30 P2O5 + 30 K2O;
 - + Treatment 4: 80 N + 50 P2O5 + 50 K2O.
- Experiment 2: Effect of plant density on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower:
 - + For Melaleuca leucadendra, it grew with 3 formulas of density: 20,000 trees/ha (with distance 1 × 0.5m); 10,000 trees/ha (with distance 1 × 1 m); and 6,666 trees/ha (with distance 1 × 1.5m).
 - + For Melaleuca cajuputi, it grew with 3 formulas of density: 40,000 trees/ha (with distance 0.5 × 0.5m); 10,000 trees/ha (with distance 1 × 0.5 m); and 6,666 trees/ha (with distance 1 × 1 m).
- Experiment 3: Effect of the flooded depth on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower:
 - + VT1: Flooded depth from 0 - 2m;

- + VT2: Flooded depth from 2 - 4m;
- + VT3: Flooded depth from 4 - 6m;
- + VT4: Flooded depth from 6 - 8m.
- For experiment 1 and 2: Interval time for growing plant is on June 2016, the last time for collecting data is on January 2017.
- For experiment 3: Interval time for growing plant is on June 2015, Time for measuring, when water is flooded, is on September 2015, the last time for measuring samples is on March 2016 after 2 months when water withdrew.

2.2.2. Collecting data and analytical method.

Arranging experiment by random way with 3 times repeated in area of 1000m², sample size per 1 time repeated (n) ≥ 30.

Measurable indicators including stem diameter (D00), height of melaleuca leucadendra (Hvn), survival rate (SR).

Data analyst: by using Excel Software, and Statistical Software SPSS 20.

Planting technique: seedlings generated in plastic bag have the average height from 100 – 120cm, and above 12 months.

[8] Result And Discussion

8.1. Determining the time interval semi-submerged land in Son La hydropower area

Table 1. Time interval semi-submerged land by month and elevation for semi-flooded area in Son La Hydropower

Month	01	02	03	04	05	06	07	08	09	10	11	12
210 - 215	////////////////////////////////////								-----			
	semi-submerged land about 8 months								Afloat			
190 - 195	-----		////////////////////////////////////						-----			
	Afloat		semi-submerged land about 5 months						Afloat			
175 - 190	-----						//////////		-----			
	Afloat						2 months		Afloat			
Level of 175m	-----											
	Afloat											

Based on the regulatory regime of river level by season and each month in one year, table above shows the correlation between river level and elevation inundation in each month in one year as follows:

- From September to December, the river level in MNDBT is 215m;
- From January water start sprint and in March water level is 190 – 195m;
- From April to the end of June water sprint quickly with MNC is 175m;
- From July to August, the river level is till stable in 175m;

Based on the table above, Time interval from January to September have time for semi-submerged land, so we can use these area in order to grow Melaleuca.

+ First stage: From height level of 210m to 215 m, time for semi-submerged land was about 8 months (from 20th January to 30th September annually, melaleuca leucadendra was grown there.

+ Second stage: From height level of 200m to 210m, time fo semi-submerged lend was about 6 months (from 30th March to 20th September annually, melaleuca leucadendra was grown up to time for water form Son La hydropower uping.

3.2. Effect of fertilizer on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower

Based on the climatic characteristics of soil that have already analyzed, soil in this area have the average annual temperature fluctuated from 22.5 – 27. 20C, the highest average temperature per each month is from 35 - 410C and the lowest average temperature per each month is from 11 - 160C, the average air humidity per year is about 82 % which rise to 84 ÷ 86 % in higher area, the average amount of rainfall per year is 2400 - 2600 mm. Soil in this area is golden brown Feralit soil with soil layer thickness ≥ 50cm, slope < 250; The soil is quite acidic with pHKCL varying from 3.95 to 5.55, the amount of aluminum (Al +) is quite low, varies from 0.09 to 0.98 ldl / 100g of soil, the concentration of humus and protein are quite low, the concentration of P2O5 and K2O are in the poor level, properties of soil: from light to medium clay.

Table 2. Effect of fertilizer on the growth capacity of Two kinds of melaleuca in semi-flooded area

Formula	Melaleuca leucadendra			Melaleuca cajuputi		
	SR (%)	D00 + SD(cm)	Hvn+SD(m)	SR (%)	D00 + SD(cm)	Hvn+SD(m)
No fertilizer (Control)	75.56	2.40±0.44a	2.42±0.45a	43.33	1.47±0.24a	1.42±0.18a
40N + 10P2O5 + 10K2O	77.78	2.50±0.46ab	2.52±0.46ab	52.22	1.56±0.20a	1.54±0.25b
60N + 30 P2O5 + 30K2O	86.67	2.73±0.57c	2.73±0.49c	63.33	1.77±0.30b	1.73±0.29c
80N + 50 P2O5 + 50K2O	81.11	2.62±0.55bc	2.60±0.53bc	57.78	1.63±0.32b	1.63±0.31bc
Result	- D00: F= 5.908 ; Sig= 0.001. - Hvn: F= 5.385; Sig= 0.001.			- D00: F=10.765; Sig= 0.000. - Hvn: F=10.984; Sig= 0.000.		

Based on experimental results of two kind of Melaleuca : (Sig<0,05) illustrates the significant distinct differences in the growth of the diameter and height of trees. These two kinds of tree (Melaleuca leucadendra and Melaleuca cajuputi) grow well both in diameter and height of melaleuca leucadendra that is in formula 3 (60N + 30 P2O5 + 30K2O). Followed by formula 4 (80N + 50 P2O5 + 50K2O), Formula have the lowest growth rate of two kinds of Melaleuca that is formula 1 (No fertilizer (ĐC)). Therefore, it is evident that using fertilizers with different rates have different effect on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower.

3.3. Effect of plant density on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower

Semi-flooded area is the area that have water level go up and down follow the elevation, so the arrangement of plant density is different in each experimental formulas. Specifically, the survival rate of Melaleuca leucadendra is highest in formula 3 (6,666 trees/ha), with the average survival rate is 85.56%, followed by formula 2 (10,000 trees/ha) with the average survival rate is 81.11%. The lowest survival rate is in formula 1 (20,000 trees/ha) that gained 72.22% in the average survival rate.

Melaleuca cajuputi have lower rate compared with Melaleuca leucadendra. Formula have the highest survival rate is formula 3 (10,000 trees/ha), with the average survival rate is 62,22%, followed by formula 2 (20,000 trees/ha) with the average survival rate is 53.33%. The lowest survival rate is in formula 1 (40,000 trees/ha) that gained 42.22% in the average survival rate.

Table 3. Effect of plant density on the growth capacity of two kinds of Melaleuca in semi-flooded area

Formula of density		Repeated	Melaleuca leucadendra			Melaleuca cajuputi		
Melaleuca leucadendra	Melaleuca cajuputi		SR (%)	D00 + SD(cm)	Hvn+SD(m)	SR (%)	D00 + SD(cm)	Hvn+SD (m)
20,000	40,000	1	76.67	2.09±0.53a	2.02±0.53a	46.67	1.34±0.19a	1.36±0.20a
		2	73.33	2.37±0.49a	2.31±0.45a	40.00	1.37±0.23a	1.30±0.17a
		3	66.67	2.36±0.44a	2.32±0.35a	40.00	1.59±0.29a	1.55±0.28a
		AVER	72.22	2.27±0.48a	2.21±0.47a	42.22	1.43±0.25a	1.40±0.23a
10,000	20,000	1	76.67	2.37±0.44b	2.32±0.43b	56.67	1.60±0.22b	1.55±0.23b
		2	86.67	2.62±0.45b	2.48±0.58b	56.67	1.74±0.36b	1.69±0.34b
		3	80.00	2.50±0.52b	2.56±0.42b	46.67	1.68±0.35b	1.62±0.31b
		AVER	81.11	2.50±0.47b	2.45±0.48b	53.33	1.67±0.31b	1.62±0.29b
6,666	10,000	1	83.33	2.65±0.44c	2.70±0.30c	66.67	1.95±0.39c	1.88±0.37c
		2	86.67	2.66±0.39c	2.56±0.34c	63.33	1.73±0.30c	1.69±0.29c
		3	86.67	2.80±0.40c	2.58±0.47c	56.67	1.75±0.26c	1.68±0.28c
		AVER	85.56	2.70±0.41c	2.61±0.38c	62.22	1.81±0.33c	1.75±0.32c
Result			- D00: F= 16.361 ; Sig= 0.000. - Hvn: F= 14.290; Sig= 0.000.			- D00: F= 17.859; Sig= 0.000. - Hvn: F= 16.464; Sig= 0.000.		

Table 3 shows that the growth capacity of Melaleuca have significant change when (Sig<0.05) as follow:

- Melaleuca leucadendra have the highest diameter and height is in formula 3 (6,666 trees/ha), with the average stem diameter (D00) is 2.70cm, and height of melaleuca leucadendra (Hvn) is 2.61m. Followed by formula 2 (10,000 trees/ha) with the average stem diameter (D00) is 2.50cm, and height of melaleuca leucadendra (Hvn) is 2.45m. Formula 1 (20,000 trees/ha) is the lowest formula,) with the average stem diameter (D00) is 2.27cm, and height of melaleuca leucadendra (Hvn) is 2.21m.

- Melaleuca cajuputi have the highest diameter and height is in formula 3 (10,000 trees/ha), with the average stem diameter (D00) is 1.81cm, and height of melaleuca leucadendra (Hvn) is 1.75m. Followed by formula 2 (20,000 trees/ha) with the average stem diameter (D00) is 1.67cm, and height of melaleuca leucadendra (Hvn) is 1.62 m. Formula 1 (40,000 trees/ha) is the lowest formula,) with the average stem diameter (D00) is 1.43 cm, and height of melaleuca leucadendra (Hvn) is 1.40 m. Furthermore, this table shows that the growth capacity of Melaleuca leucadendra is from 0.6 to 1 times higher than that in Melaleuca cajuputi in all formulas of planting density.

3.4. Effect of the flooded depth on the growth capacity of Melaleuca leucadendra and Melaleuca cajuputi in semi-flooded area in Son La Hydropower.

- Water level go up and down will affect the survival rate of two kinds of Melaleuca, as followed:

- For Melaleuca leucadendra, when appearing the shallow water phenomenon the survival rate of Melaleuca leucadendra is 87.78%, 84.44%, 86.67%, 85.56% respectively for the different flooded depth when grow plant have approximately survival rate. Meanwhile, when water go up the survival rate decreases with the depth from 0 – 2m, 2 -4m, 4-6m and 6-8m corresponding with 82.22%, 57.78%, 36.67%, and the lowest is 22.22%, in significant level is 0.05.

- Melaleuca cajuputi is quite similar with Melaleuca leucadendra, but the survival rate is lower. When not flooded, the survival rate of Melaleuca cajuputi is 63.33%, 62.22%, 63.33%, 60.00% respectively. When water is flooded, the survival rate reduce with the depth is 56.67%, 31.11%, 27.00%, 13.33% respectively.

Table 4. Effect of the flooded depth on the growth capacity of two kinds of Melaleuca in semi-flooded area

Formula of density		plant original (m)	Melaleuca leucadendra			Melaleuca cajuputi		
			SR (%)	D00 + SD(cm)	Hvn+SD(m)	SR (%)	D00 + SD(cm)	Hvn+SD(m)
0-2 (m)	parched	1.20	87.78	1.37±0.13a	1.36±0.13a	63.33	1.28±0.18a	1.26±0.14a
	awash		82.22	1.73±0.31c	1.68±0.26c	56.67	1.51±0.23c	1.51±0.32b
2-4 (m)	parched	1.20	84.44	1.36±0.14a	1.35±0.13a	62.22	1.27±0.16a	1.27±0.25a
	awash		57.78	1.62±0.27bc	1.57±0.24bc	31.11	1.41±0.18bc	1.40±0.32ab

4-6 (m)	parched	1.20	86.67	1.35±0.16a	1.34±0.12a	63.33	1.29±0.19a	1.26±0.18a
	awash		36.67	1.54±0.30ab	1.50±0.30b	27.00	1.32±0.16ab	1.32±0.15a
6-8 (m)	parched	1.20	85.56	1.35±0.15a	1.35±0.14a	60.00	1.28±0.18a	1.27±0.19a
	awash		22.22	1.45±0.15a	1.38±0.16a	13.33	1.28±0.07a	1.28±0.07a
Result		parched	- D00: F=0.294; Sig= 0.829 - Hvn: F=0.256; Sig= 0.857			- D00: F=0.131; Sig= 0.942 - Hvn: F=0.062; Sig= 0.980		
		awash	- D00: F=6.754; Sig= 0.000 - Hvn: F=8.567; Sig= 0.000			- D00: F=7.537; Sig= 0.000 - Hvn: F=4.022; Sig= 0.009		

- Table 4 shows that the flooded depth have significant influence to the survival rate of two kinds of Melaleuca as followed:

- - For diameter:

- Melaleuca leucadendra: when appearing the shallow water phenomenon, stem diameter (D00) of these trees do not have the difference compared with the experimental formula (Sig= 0.829>0.05),while in the flood level is 1.37, 1.36, 1.35, 1.35, respectively. However, when water go up and cover whole trees, the results after measuring samples after 2 months showed the significant difference (Sig= 0.000<0.05). The highest stem diameter is from 0 – 2m and 1.73cm, and the stem diameter of these trees decreased slightly to 1.62, 1.54, 1.45 respectively. These results showed the distribution about stem diameter of Melaleuca leucadendra when water level is parched and awash.

- It is similar for Melaleuca cajuputi: when appearing the shallow water phenomenon, stem diameter (D00) of these trees do not have the difference compared with the experimental formula (Sig= 0.942>0.05),while in the flood level is 1.28, 1.27, 1.29, 1.28, respectively. However, when water go up and cover whole trees, the results after measuring samples after 2 months showed the significant difference (Sig= 0.000<0.05). The highest stem diameter is from 0 – 2m and 1.51cm, and the stem diameter of these trees decreased slightly to 1.41, 1.32, 1.28cm, respectively. These results showed the distribution about stem diameter of Melaleuca leucadendra when water level is parched and awash.

- For height of melaleuca leucadendra:

- Melaleuca leucadendra: when appearing the shallow water phenomenon, the growth of height of melaleuca leucadendra (Hvn) of these trees do not have the difference compared with the experimental formula (Sig= 0.857>0.05),while in the flood level is 1.36, 1.35, 1.34, 1.35m, respectively. However, when water go up and cover whole trees, the results after measuring samples after 2 months showed the significant difference (Sig= 0.000<0.05). The highest stem diameter is from 0 – 2m and 1.68cm, and the stem diameter of these trees decreased slightly to 1.57, 1.50, 1.38cm, respectively.

- Melaleuca cajuputi: when appearing the shallow water phenomenon, the growth of height of melaleuca leucadendra (Hvn) of these trees do not have the difference compared with the experimental formula (Sig= 0.980>0.05),while in the flood level is 1.26, 1.27, 1.26, 1.27m, respectively. However, when water go up and cover whole trees, the results after measuring samples after 2 months showed the significant difference (Sig= 0.009<0.05). The highest stem diameter is from 0 – 2m and 1.51cm, and the stem diameter of these trees decreased slightly to 1.40, 1.32, 1.28cm, respectively.

- Therefore, the results above showed that both of these Melaleuca could grow and develop in semi-flooded area. When these trees grow partially in submerged environment, The roots of Melaleuca trees will grow better than that when they are not flooded. However, it also depends on the flooded depth that trees can grow and develop normally when water flooded. In addition, the results illustrated that the adaptability of Melaleuca leucadendra in semi-flooded area is more suitable than Melaleuca cajuputi.

[9] Conclusion

The results above showed that the experimental formulas about fertilizer, planting density, flooded depth have large influence on the growth and development of two types of Melaleuca in semi-flooded area.

+ For Melaleuca leucadendra:

- Fertilizers: the best formula is 60N + 30P2O5 + 30K2O;
- Planting density: we can grow Melaleuca leucadendra with the plant density that is 10,000 trees/ha and 6,666 trees/ha;
- Flooded depth: ranging from 0 to 6 m.

+ For Melaleuca cajuputi

- Fertilizers: the best formula is 60N + 30P2O5 + 30K2O;
- Planting density: we can grow Melaleuca cajuputi with the plant density that is 20,000 trees/ha and 10,000 trees/ha;
- Flooded depth: ranging from 0 to 4 m.

- In addition, the results above indicated that Melaleuca leucadendra could grow and

develop in semi-flooded area better than Melaleuca cajuputi. About requirements when we grow Melaleuca in semi-flooded area in Son La hydropower: we can grow Melaleuca immediately after water go down and we could grow Melaleuca in the elevation from 200m to 215m. From January to September, it is suitable to utilize non-flooded areas for planting Melaleuca.

[10] References

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