Effect of biochar and partial peeling of stems on soil fertility and germination of *Erythrina variegata* cuttings

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Abstract

The purpose of this study was to evaluate the use of biochar and partial peeling of the stems to accelerate the germination of *Erythrina Variegata* stem cuttings. The experiment was designed as a 2*5 factorial in a completely randomized design (CRD) with four replicates. The factors were: 1. Peeling of stem (P: Peeled, N: Not peeled); 2. Biochar levels of 0, 1, 2, 3 and 4 % of soil. The trial was conducted in the field laboratory of the Research and Technology Transfer Center, in Nong Lam University, Vietnam, from May to July 2015. Peeling was by scraping off the epidermis of the bottom 3cm of the stake cuttings. The cuttings were planted in soil in plastic bags (2 liter capacity).

Biochar improved soil fertility, with greater water holding capacity and increase in pH. Rate of germination of Erythrina cuttings was increased by biochar and by peeling the stems.

Key words: *pH, organic matter, water holding capacity*

Introduction

Biochar has been shown to improve soil fertility and growth rates of many plants and vegetables (Lehman and Joseph 2009; Southavong and Preston 2011; Chhay et al 2013; Preston 2015). However, there appear to be no studies on effects of biochar on germination and establishment of forage trees such as *Erythrina Variegata.*

The common method for planting many forage trees is by inserting in the soil the stakes cut from young growing branches. It has also been observed that when the cortex is removed (peeled) from the lower part of the stake, the rate of germination is increased (Moreno et al 2005).

The purpose of the present study was to compare the effects on germination of *Erythrina poeppigiana* of adding biochar to the soil, and of peeling the cortex of the lower 4cm of the stake, prior to inserting the stake in the soil.

Hypothesis

- Biochar, and / or peeling of the lower 3cm, will increase the rate of germination and growth of stem cutting of *Erythrina Variegata*

Materials and methods

Location and duration

The experiment was conducted experimental area of the Research and Technology Transfer Center, in Nong Lam University, Vietnam, from May to July 2015.

Experimental design

The experiment was designed as a 2*5 factorial in a completely randomized design (CRD) with four replicates. The factors were:

Peeling of stem:

- P: Peeled
- N: Not peeled

Level of biochar:

· 0, 1, 2, 3 and 4 % of the weight of the soil.

Photo 1. Peeling of the lower 3cm of the stakes

Procedure

Erythrina branches were selected with 5-7 leaves and which were about 25cm long and 1- 3cm in diameter. The branches were cut into stakes about 20cm in length. Alternate stakes were then peeled (the cortex was removed over the last 3cm of the stake) or not peeled (Photo 1).

Biochar was prepared from rice hulls in a top-lit gasifier stove (Olivier 2009) (Photo 2).

Photo 2. Preparing the biochar by combustion of rice husk

Top soil (5-20cm) was dried in the shade for 7 days, then cleaned by removing waste material and sieving through mesh size of 10mm. Samples were taken to measure moisture, texture, pH, organic matter (OM) and water-holding capacity (WHC) using standard methods (AOAC 2000).

The soil was mixed with the indicated quantities of biochar and put in plastic bags of 2 liters capacity (Photo 3).

Photo 3. The cuttings beginning to germinate

Data collection

Data were collected weekly on presence of buds, leaves and branches.

Statistical analysis

The data were analyzed by the GLM option in the ANOVA program of the Minitab software (Minitab 2000). Sources of variation were: biochar levels, peeling, interaction biochar*peeling and error.

Results and discussion

The composition of the soil (Table 1) with organic matter of 5% together with the particle analysis (Table 2) means it was a sandy clay loam quite rich in OM.

Table 1. Characteristics of the biochar and the soil before planting

	Soil	Biochar
pH	5.5	10
DM, %	86.6	98.7
OM, %	4.2	

Table 2. Assessing soil texture

Texture	Sandy clay loam
Sand, %	60
Silt, %	15
Clay, %	25

After 5 days the Erythrina cuttings began to sprout shoots which later developed into leaves (Photo 3).

Soil pH was increased linearly from 5.04 to 5.38 by adding biochar (Table 3; Figure 1).

Table 3. Mean values for Soil with 5 levels of biochar

	Level of biochar, %					
	0	**1**	**2**	**3**	**4**	**SEM**
pH	5.57	5.86	6.12	6.37	6.55	0.03

Figure 1. Biochar increased soil pH

Water holding capacity of the soil revealed linear increases of up to 50% as the level of biochar in the soil was increased (Table 4; Figure 2).

Table 4. Mean values for water holding capacity (WHC) of the soil with 5 levels of biochar

	Level of biochar, %					
	0	**1**	**2**	**3**	**4**	**SEM**
WHC 1 day	40	50	55	58	60	0.28
WHC 35 day	45.25	56.75	60.25	62.5	63.75	0.03

Figure 2. Biochar increased the water–holding capacity of the soil

The rate of germination was increased by peeling the stakes and by adding biochar to the soil (Table 5; Figure 3).

Table 5. Effect of peeling the stakes of Erythrina on germination

	Buds, 21d	Stems, 35d	No leaves, 35d	Branch, cm
Not peeled	1.52	1.36	3.74	4.90
Peeled	3.45	3.35	6.75	8.45

Figure 3. Effect of peeling Erythrina stems on germination: buds (21 days), growth of stems, leaves, branches (35 days)

Discussion

Both interventions (stem partial peeling and addition of biochar to the soil) resulted in faster rate of germination. This appears to be an original finding both for the effect of peeling and of biochar as we found no comparable data in the literature. The response to partial peeling of the cutting would appear to be a logical reaction of the plant to protect itself against the injury caused by the peeling of the cortex.

The beneficial effect of the biochar soil amendment on germination presumably reflected the improved uptake of nutrients resulting from the improved habitat for soil micro-organisms and nutrients as a result of the support to biofilm formation that is one of the attributes of the biochar (R A Leng, personal commujication). The increases in soil pH and water-holding capacity are also beneficial for plant growth.

Conclusions

- The rate of germination of cuttings of *Erythrina poepiggiana* was increased by partial peeling

of the stakes and by adding biochar to the soil.

- pH and water-holding capacity of the soil were increased linearly by adding up to 4% of biochar to the soil in which the cuttings were planted.

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Go to top