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The Effect of Seedlings Density in Nursery on Biomass Production and Growth Characteristic of *Styrax obassia*

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Abstract. To provide the basic data essential for developing varieties of broad-leaved tree, the study investigated the utmost growth requirement for the growth characteristic and biomass production in accordance with planting density of *Styrax obassia*. The planting density of seedling can be a significant factor in contributing growth of seedling for tree growing in general. While growth of tree according to 1 m^2 planting density of *Styrax obassia* showed an excellent growth in tree height and the root collar diameter from 49 no./m^2, those low planting density showed decreased tendency with tree height growth while increasing the root collar diameter growth. As similar to the growth characteristic, the biomass production showed significant and statistic difference in 49 no./m^2, showing high volume of biomass production which is 3.12 ± 0.80 g compare to other processing section and high figure with T/R ratio which is 1.59. The special trait of photosynthetic also showed relatively high photosynthetic rate in 49 no./m^2 and 64 no./m^2 of *Styrax obassia* and as the density increase, photosynthetic efficiency decreased. The plant showed stable and physiological planting pattern, displaying the best photosynthetic rate, which was the final metabolism through reserving proper space in the growth and development environment condition. This obstacle of required space essential for growth substantially deteriorated planting and ultimately, it demonstrated lower tendency of photosynthetic rate, which is the highest level of metabolism.

Key words : *biomass production, growth characteristics, planting density,* Styrax obassia

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Introduction

The change of recent forest policy is to organize a forest resource that is economically and environmentally advanced such as public silviculture business of livelihood rights, recovery from a forest fire and silviculture planting. In addition, while planting different species of trees adjusted to districts' particular traits, the policy is endeavoring in contributing development of districts and expanding profits. In order to realize the plan, a development of a various silviculture species trees is essential.

Styrax obassia, one of indigenous trees is a kind of tree that grows in the fields and mountains all over the nation. *Styrax obassia* get its common name, Fragrant Snowbell, from the 15 to 20 cm long raceme of fragrant, white, bell-shaped flowers produced May to June (Lee, 1989). Tree height of *Styrax obassia* is a sub-tall, 8-10 m, deciduous tree that is appropriate as a patio tree where the attractive bark with orange-brown vertical fissures can be appreciated at a close distance, or *Styrax obassia* can add color to the mixed shrubbery border. The wood is used for making shelves and its fruits are used as oil.

The study attempted to produce an excellent nursery (Bormann and Gorden, 1984; Chung *et al*, 1984; Iwaki, 1959; Ma, 1976), the *Styrax obassia*, which is being widely used in landscape forest, highly evaluated and recognized as a great landscape.

The study tried to provide basic data on broad-leaved trees for development through analyzing its growth characteristics and volumes of biomass production to investigate the optimum growth condition in accordance with planting density.

Material and Methods

The sampling for this experiment were obtained in 2005 when it was open-buried at the experimental forest within Forest Production Research Center, Korea Forest

Research Institute located in Pocheon. It was planted in the nursery bed within Forest Production Research Center on April 2006 using random sowing. The dimensions after sprout were processed in 5 treatments (36, 49, 64, 81, and 90 no./m^2) and arranged in 3 repetitions.

The growth characteristics investigation for proper growth density took place at the end of September when it began interphase after some growth period by treatment section, respectively. The seedling height and root collar diameter were measured using both digital vernier calipers (Mitutoyo co. Japan) and steel tape (2 m). After the measurement, the T/R ratio and the volume of dry weight were investigated as per the processing section. All data executed a statistics processing using SAS program (SAS Inc., 1996). During the positive growth period of the plant, which is the early part of July, 3 standard sample trees of each processing section were selected. The subject tree to be experimented was given net photosynthesis measurement comparison using a portable photosynthesis system (LI-6400, Li-Cor. Inc.). Light-saturated net photosynthesis (An) was measured on fully expanded, mature leaf number 4 counted from each shoot apex on every individual in the treatments. Net photosynthesis was measured with a broad-leaf cuvette of the Li-cor 6400 potable photosynthesis System (Li-cor Inc., USA), the leaf was sealed and CO_2 concentration was allowed to be maintained at ambient levels. Air flow through the analyzer was adjusted to maintain leaf cuvette relative humidity near ambiebt level 70±10%) during measurement. The average cuvette temperature was maintained at 25°C. For photosynthesis capacity, this study measured the light-photosynthesis curve by adjusting the light intensity from 0 to 2,000 μmol m^{-2} s^{-1} with a photosynthesis analyzer (Choi, 2001; Woo *et al.*, 2003).

Net Photosynthesis was calculated as:

$$A_n = \frac{u_e(c_e - c_c)}{100s} - c_c E$$

A_n; net photosynthesis (μmol CO_2 m^{-2} s^{-1}), u_e; mole flow rate of air entering the leaf chamber (μmol s^{-1}), c_e; mole fraction of CO_2 in the leaf chamber (μmol CO_2 mol^{-1} air), c_c; mole fraction of CO_2 entering in the leaf chamber (μmol CO_2 mol^{-1} air), s; leaf area (cm^2), E; transpiration (mmol H_2O $m^{-2}s^{-1}$)

This study also performed a regression analysis and obtained photosynthesis curves using SigmaPlot (SPSS Inc.) to estimate precise light-photosynthesis curves and light compensation points.

$$y = yo + ax/(b+x)$$

A light compensation point is obtained when y=0 in the equation above.

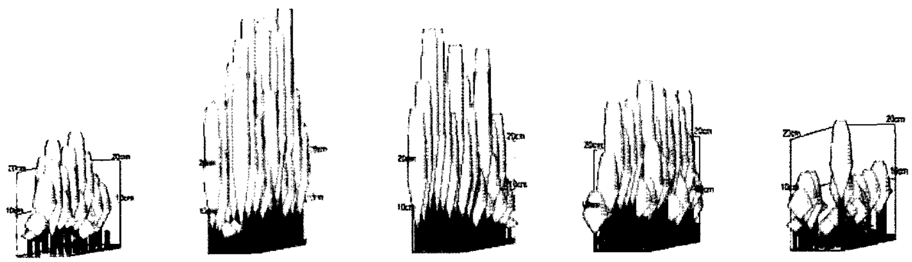
Results and Discussion

The following is the result of investigation to find out optimum growth density for effective *Styrax obassia* production.

Growth Characteristics

The planting density is a significant factor that considerably affects plant's growth (Bormonn and Gorden, 1984; Chung *et al*, 1984; Donald, 1961; Goo *et al*, 1995; Krammer and Kozlowski, 1979; Ma, 1976; Per and Karl; 2000). In order to analysis growth of plant as per planting density, a 3D analysis was executed on investigated seedling height (Fig. 1).

While the growth of trees according to planting density



36 no./ m^2 49 no./ m^2 64 no./ m^2 81 no./ m^2 90 no./ m^2

Fig. 1. Growth characteristics of one year seedlings of *Styrax obassia* by 5 different densities.

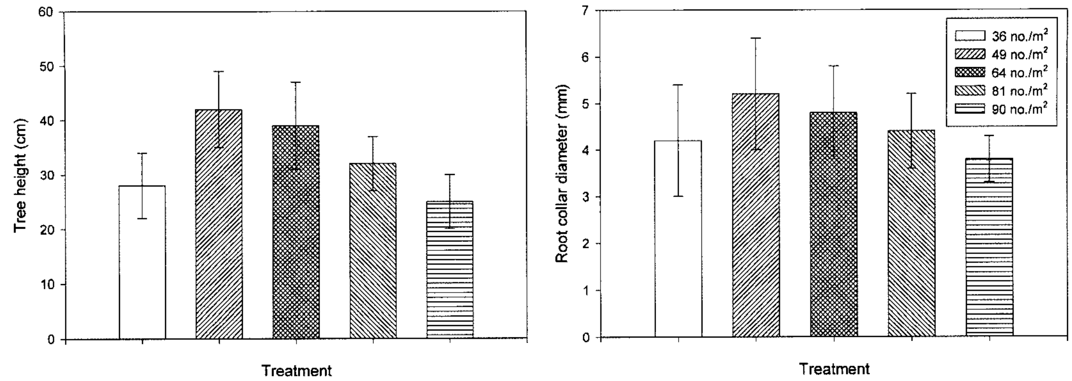


Fig. 2. The growth performances of height (left) and root collar diameter (right) in the seedlings of *Styrax obassia* subjected to 5 different densities. Values are means ± Standard Deviation.

Table 1. Biomass production and T/R ratio of one year seedlings of *Styrax obassia* by 5 different densities.

Treatment (No./m^2)	Dry weight (g)			T/R ratio
	Top	Root	Total	
36	1.51±0.97 b*	0.98±0.54 c	2.49±0.76 c	1.55±0.64 b
49	1.91±0.67 a	1.20±0.93 a	3.12±0.80 a	1.59±0.70 a
64	1.43±0.83 c	1.10±0.76 b	2.54±0.80 b	1.30±0.55 e
81	1.18±0.39 d	0.78±0.20 d	1.96±0.30 d	1.51±0.58 c
90	0.65±0.66 e	0.46±0.64 e	1.11±0.65 e	1.43±0.49 d

*; Different letters within a column indicate statistical differences at the 5% level by Duncan's multiple range test. Values are means ± Standard Deviation

per 1 m^2 of a plant is 41.4±11.3 cm 5.3±0.9 cm for tree height and the root collar diameter in 49 no./m^2, showed an excellent growth volume compare to other planting density, the ones with low planting density showed improvement in the root collar diameter growth but low tree height growth and at the high tree density of 81, 90 no./ m^2 processing section, it showed tendency of rapid decrease of growth volume such as tree height and the root collar diameter (Fig. 2).

Biomass production

The biomass production also showed high planting density in 49 no./ m^2 similar to the special trait of growth characteristic (Sarvas, 2001; Veiko *et al*, 2007). The ground section showed 1.91±0.67 g, while the underground section showed 1.20±0.93 g which is 3.12±0.80 g for the total biomass production showing significance to other processing section and high volume of mater production and even the T/R ratio showed high figure which is 1.59 (Table 1).

Characteristic of Photosynthesis

Despite plants tend to show physiological and stable growth pattern while displaying the utmost photosynthetic rate which is the final metabolism through reserving proper space in a planting environment, an obstacle

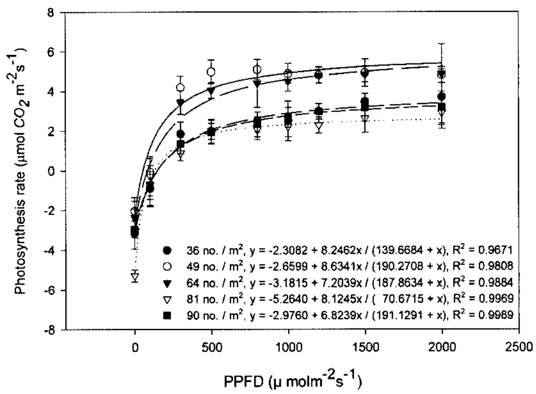


Fig. 3. Photosynthesis rate of *Styrax obassia* seedlings grown under 5 different densities in July. PPFD means photosynthetic photon flux density.

of required space essential for growth would bring deterioration on growth and low photosynthetic efficiency which is the highest level of metabolism (Donald, 1961; Jin, 1972; Williams, 1963). In other words, within high density of more than appropriate density that would decline photosynthetic ability of trees growing in the similar environment (Akkin, 2005; Goo *et al*, 1997; Park *et al*, 1984), it could be regarded that the required light is decreased due to overlap of leaves. In this study of *Styrax obassia*, it showed 49 no/m^2 which determined to be an appropriate planting density and 64 no./m^2 photosynthetic rate which is relatively high thus resulting the photosynthetic efficiency decrease as the density is increased (Fig. 3).

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생육밀도가 쪽동백나무 유묘의 물질생산량과 생장특성에 미치는 영향

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적 요. 다양한 활엽수 자원의 개발에 필요한 기초자료를 제공하고자 쪽동백나무 유묘의 생육밀도에 따른 물질생산량과 생장특성 등 최적의 생장조건을 조사하였다. 묘목의 생육밀도는 수고생장에 크게 영향을 미치는 중요한 요인이 될 수 있으며, 본 실험 결과 쪽동백나무의 1 m^2당 생육 밀도에 따른 묘목의 생장은 49본구에서 간장과 근원직경이 우수한 생장량을 보인반면 생육밀도가 낮은 처리구는 근원직경 생장이 증가하면서 간장생장은 떨어지는 경향을 보였다. 물질생산량 또한 생장 특성과 마찬가지로 1 m^2당 49본구 처리구에서 전체 물질생산량이 통계적으로 유의적인 차이를 보이면서 3.12±0.80 g로 다른 처리구보다 높은 물질생산량을 보였고, T/R율에서도 1.59로 나타났다. 생리적 특성으로 광합성률 또한 쪽동백나무의 경우 1 m^2당 49/m^2 본구와 64/m^2 본구에서 상대적으로 높은 광합성률을 보였고 밀도가 높아질수록 광합성 효율이 떨어지는 결과를 나타냈다. 이는 생육 환경조건에서 적절한 공간 확보가 궁극적으로 최종 물질대사 작용인 광합성률 변화에서 최적의 상태를 보이면서 생리적으로 안정된 생장형태를 보이는 것으로 판단되며, 적정 공간의 장애가 실질적인 생장저하를 발생시키고, 궁극적으로 물질대사의 최고 단계인 광합성효율 또한 낮아지는 경향을 나타냈다.

주제어 : 쪽동백나무, 식재밀도, 생장특성, 물질생산량