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Studies on Photosynthetic and Fluorescence Characteristics of Young and Mature *Magnolia officinalis*

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Abstract: The 1 year and 5 years old *M. officinalis* cultivated in Linfeng Village Beichuan county were detected using the Li-6400XT and PAM-2500 in a sunny day. The results showed that Photosynthetic rate (Pn), Transpiration rate (Tr), stomatal conductance (Gs), NPQ and Fv/Fm of 5 years old *M. officinalis* were higher than that of 1 year old *M. officinalis*. The 5 years old *M. officinalis* was thought to be a better suitable for wider living site after comparative analyzing both the photosynthetic and fluorescence parameters.

Key words: *Magnolia officinalis*, photosynthetic characteristics, fluorescence characteristics, NPQ, comparitive analyzig

INTRODUCTION

Magnolia oficinalis Rehd. et Wils. (Magnoliaceae) is a deciduous tree, distributed inthe Yangtze River Basin and Southern China. The stem and root bark of *M. oficinalis* (Chinese name: Hou po) has been used as a traditional medicine for the treatment of gastrointestinal complaints, asthmatic cough, thrombotic stroke, anxiety and nervous disturbance.

With the development of pharmacological research of the magnolia, the scope of its clinical application has been expanding more and more fields in recent years. Its artificial cultivation increases rapidly along with the demand of magnolia officinalis medicinal materials. At present, the study of *M. oficinalis* mostly focus on chemical composition, measuring method, extraction technology, preparation, pharmacological action, clinical application and cultivation techniques (Yuan *et al*., 2010; Liu *et al*., 2006; Liu *et al*., 2007; Wang *et al*., 2007; Li *et al*., 2008; Wang *et al*., 2012) only a few studies emphasize on the photosynthetic physiological characteristics of *M. officinalis*. Photosynthesis of green plant is the major energy source for organisms on earth to survive and develop. The different photosynthetic characteristics is one of the direct reasons of different growth and resistance of plant (Yan *et al*., 2008). This study was carried out to study the effect of net photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2 concentration under field conditions. The photosynthetic characteristics and chlorophyll fluorescence parameters of young and matrue *M. officinalis* were studied to found out new method that could enhance yield, qulity and adaptability to the environment of *M. officinalis*.

MATERIALS AND METHODS

Experiment plot: The experiment plot locate at Linfeng Village Beichuan County. Beichuan has a humid subtropical climate, 1700 m above sea level, annual average temperature 15.4°C, annual sunshine hours 1050 h, 1100 mm annual rainfall and annual frost-free season 240 days.

Material: The 1 a young *M. officinalis* with height of 0.3 m, 0.6 cm in diameter and 5a *M. oficinalis* with height of 3.5 m, 3.0 cm in diameter were studied.

Detecting photosynthetic characteristics: The photosynthesis of *M. oficinalis* were studied with Li-6400 XT portable photosynthetic apparatus (Li-COR company, USA). Each plant used 3 mature leaves and each leaf recorded 5 measurements. It was randomly selected branches outside, central fully extended, no plant diseases and insect pests and mechanical damage of sun mature leaves from the plant of height and ground diameter were mostly identical, spatial orientation and consistent as far as possible. Setting the photon flux density 300 mol m^{-2} sec^{-1}, temperature (25±1)°C, CO_2 concentration (400±10) mol L^{-1} when the net

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Photosynthetic rate (Pn), intercellular CO_2 concentration, stomatal conductance and transpiration rate were measured from 9:00-11:00. The instantaneous Water Use Efficiency (WUE) and Light energy Use Efficiency (LUE) were calculated.

$$WUE = Pn/Tr, \ LUE = Pn/PAR$$

Detecting fluorescence characteristics: The same leaf was selected on sunny morning 9:00-11:00, June 20, 2013 which was marked blade fully dark adaptation for 20 min. The kinetic parameters of chlorophyll fluorescence induction, the original light energy conversion efficiency of PSII (Fv/Fm) and photochemical quenching coefficient of qP, Non Photochemical Quenching (NPQ) equivalence were monitored using the PAM-2500 (WALZ company, Germany) portable pulse modulation chlorophyll fluorescence spectrometer. Each department of young and mature *M. officinalis* selection 3 strains, each repeated 5 times.

RESULTS AND DISCUSSION

Comparision of photosynthetic indexes: As can be seen from Fig. 1, the young and mature *M. officinalis* had many significant differences in photosynthetic characteristics. Net photosynthetic rate was one of the most important parameters of plant photosynthetic characteristics. The net photosynthetic rate of 1 a young *M. officinalis* was 7 mmol CO_2 m^{-2} sec^{-1} and its value was only 73.8% of 5 a mature *M. officinalis* which indicated that net accumulation of photosynthetic product capacity of 5a was higher than that of 1a.

In this study, stomatal conductance and intercellular CO_2 concentration of 5 a mature were greater than that of 1 a young *M. officinalis* which showed that the decline of photosynthesis of 1 a young *M. officinalis* was mainly due to the decline of stomatal conductance.

Transpiration, the crux for the bio-activityofplants is essential for the physiological process of plants. Leaf water potential and transpiration velocity of plant are 2 important physiologic index that reflect water regime of plant.

The transpiration rate of 5 a *M. officinalis* was 1.50 mmol H_2O m^{-2} sec^{-1} which was higher than that 1.00 mmol H_2O m^{-2} sec^{-1} of 1 a young *M. officinalis*.

Comparison of WUE and LEU: As can be seen from Fig. 2a, the young and mature *M. officinalis* had many significant differences in WUE and LEU. The WUE value of 1 a young *M. officinalis* is higher than that of 5 a mature *M. officinalis* in this study which indicated that

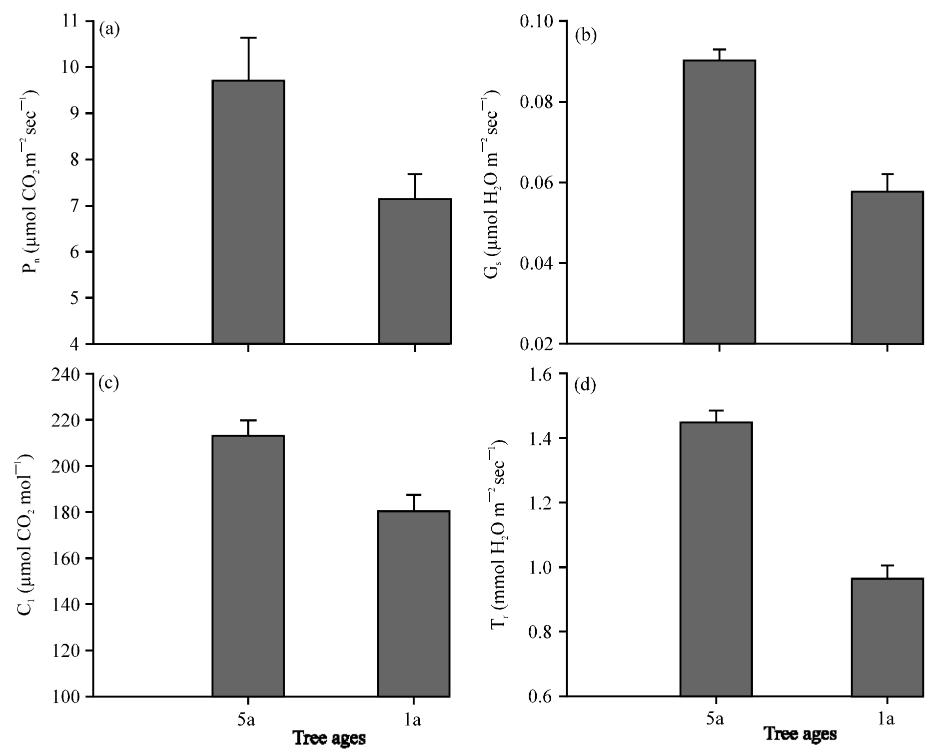

Fig. 1: Comparision of photosynthetic indexes between 1 and 5a *Magnolia officinalis*

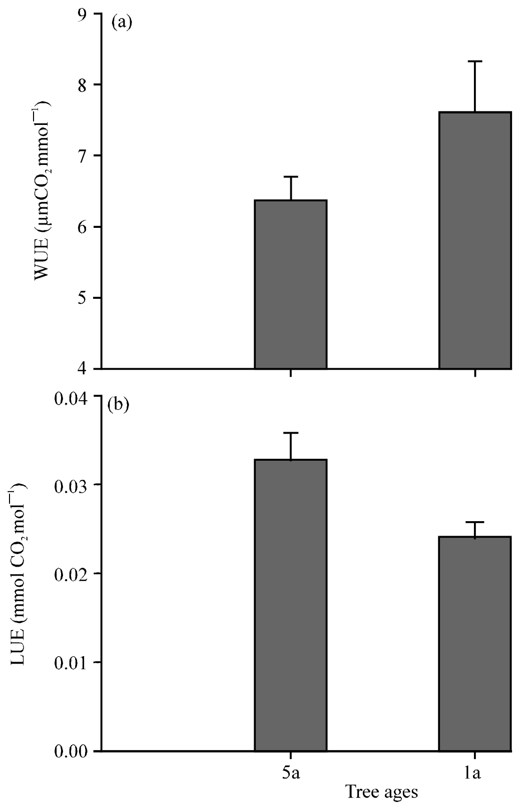

Fig. 2: Comparision of WUE and LUE between 1 and 5a *Magnolia officinalis*

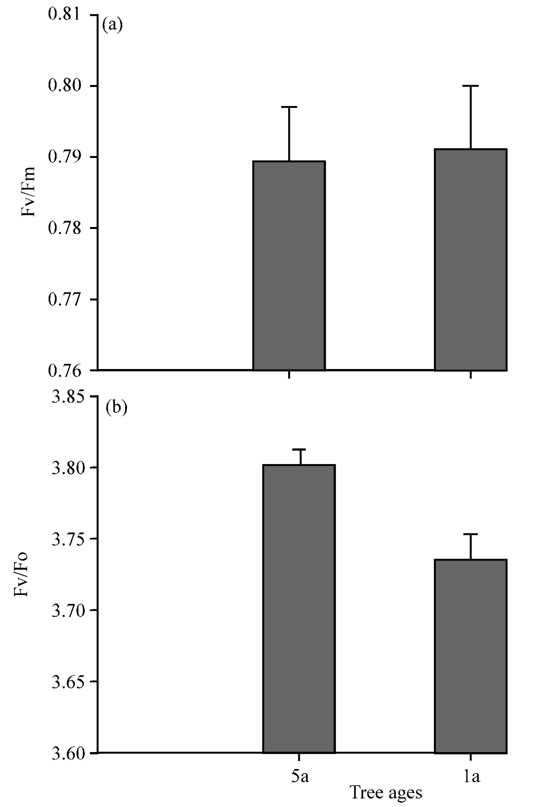

Fig. 3: Comparision of F_v/F_m and F_v/F_o between 1 and 5a *Magnolia officinalis*

high photosynthetic rate of 1a young *M. officinalis* was based on high transpiration. From Fig. 2b at the same unsaturated light intensity (300 mmol m^{-2} sec^{-1}), the light energy utilization rate of 5a *M. officinalis* was higher than that of 1a young *M. officinalis* and this may be related to the development degree of leaf tissue structure.

Comparison of F_v/F_m and F_v/F_o between 1 and 5a *Magnolia officinalis*: Fv/Fm was measured by the leaf dark adaptation after 20 min which reflected the biggest light energy conversion efficiency of PSII reaction center. The variation of Fv/Fm was tiny under no stress condition not affected by species and growth condition. But, Fv/Fm was markedly reduced under stress condition. As can be seen from Fig.3, the Fv/Fm value of 5 and 1a *M. officinalis* was 0.791 and 0.789, respectively which were almost the same. The Fv/Fm value of *M. officinalis* in this study was to around 0.79, showed that the investment environment was suitable for its growth.

Fv/Fo reflected the potential activity of PSII, also indicates the plants' resistant. The value of 5a was 3.80, significantly higher than 3.75 of 1a young *M. officinalis* and showed that with the increase of tree age, its resilience increasing.

Comparision of actual photochemical quantum yield and photochemical quenching: Non photochemical quenching reflects the PSII antenna pigment absorption of light energy that can not be used for electron transfer and part of escaping light energy in the form of heat. NPQ is a kind of plant protection mechanism and has certain protective effect on photosynthetic mechanism. In this study, from Fig. 4a-c, the yield value of 1a was 0.52, higher than that of 5 a mature *M. officinalis*. The qP of 1a *M. officinalis* was 0.83, higher than that 5a *M. officinalis*'s 0.76. However, the NPQ value of 5a mature *M. officinalis* was 0.92, higher than that of 1a young *M. officinalis* which showed that with the increase of tree age, the light protection mechanism development more perfect and increase resilience.

Stomata controlled gas and moisture exchanges between the plant and the external atmosphere and they play an important role in plant photosynthesis and transpiration (Zhang, 2003; Gong *et al*., 2005). Intercellular CO_2 concentration was 1 of the most crucial parameter in photosynthetic physiological ecology, especially in stomatal limitation analysis in photosynthesis which was the main cause of the change of the photosynthetic rate

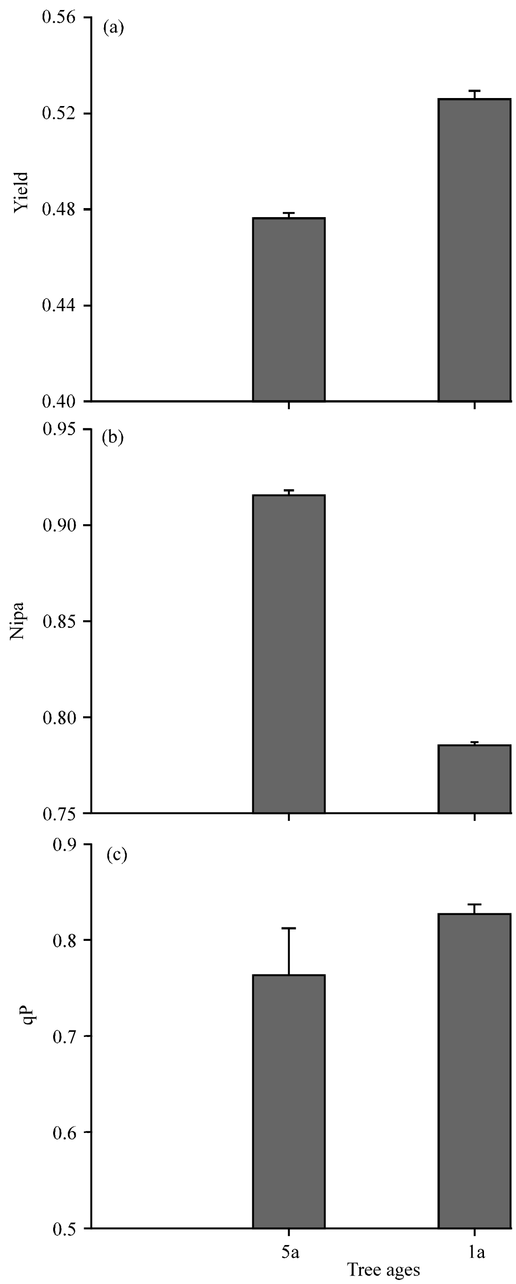

Fig. 4: Comparision of yield, NPQ and qP between 1 and 5a *Magnolia officinalis*

and the judgment of stomatal factors (Xu, 1997). Farquhar and Sharkey (1982) think if P_n reduced along with C_i and G_s at the same time, the stomatal closure stomatal limitation is the main reason of the reduce of P_n, if P_n decrease along with the C_i rising and falling G_s, non stomatal limitation of photosynthetic activity decline caused by non stomatal limitation was the main reason for the P_n decrease. WUE reflected the amount of CO_2 per unit of weight water pruduces for plant consumption and the relationship between water consumption and the dry matter (Li *et al*., 2000). Photochemical quenching reflected the PSII reaction center's openness and PSII electron acceptor original QA reduction state of the PSII reaction center, the greater the value, the higher the activity of PSII electron transfer (Wang *et al*., 1997).

The actual nature ecological environment is very complicated and photosynthesis in plants is a complex physiological process. It is mainly dependent upon Photosynthetic Active Radiation (PAR) and local weather conditions, such as temperature and relative humidity. The ecological factors had indirect effect on the net photosynthetic rate of these species by influencing stomatal conductivity and intercellular CO_2 concentration (Xu, 2002).

Net photosynthetic rate, stomatal conductance and transpiration rate of 5a *M. officinalis* were greater than that of 1a young *M. officinalis* which indicated that with the increase of tree age, assimilation ability of CO_2 increase gradually and this conclusion was in accord with the result on Carallia diplopetala (Liang *et al*., 2010). As a result of the experimental materials of treatment was less in this study, so the conclusion drawn from this study needed to be testified in the later study.

The chlorophyll fluorescence kinetics technique was referred to as a quick and non intrusive probe in the studies of plant photosynthetic function which was a new shortcut of introduction and acclimatization and construct breeding variety (Chen *et al*., 2006). The light energy dissipation of chlorophyll absorbs was mainly through the photochemical reaction, heat and fluorescence and energy competition of 3 mainly reflect between photochemical quenching and non photochemical quenching energy competition.

CONCLUSION

NPQ and Fv/Fm value of 5a mature *M. officinalis* are higher than that of 1a young *M. officinalis* which shows that with the increase of tree age, the light protection mechanism development more perfect and increase resilience. The qP and yield value of 1a young *M. officinalis* are higher than that of 5a *M. officinalis*, the PSII electron transfer activity and original light energy capture efficiency are higher than that of 5a mature *M. officinalis* because of a strong growth period of 1a young *M. officinalis*. NPQ value of 1 a *M. officinalis* is below that of 5a *M. officinalis* but the WUE value is higher than that of 5a *M. officinalis* which shows that the light protection mechanism of 1a *M. officinalis* development is not perfect and has a greater demand for water in this study. Therefore, it is necessary to provide shade treatment and water supply for 1a *M. officinalis* to ensure the efficient photosynthesis.

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