Comparative Study on Heredity and Physiology of Toona sinensis and Toona tomentosa

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Abstract: Toona sinensis is one of the precious timber tree species in China, known as mahogany in China. Toona tomentosa is a Endemic Tree Species in China. It mainly occurs in Sichuan, Guizhou, Fujian and Anhui. It is vertically distributed in the range of 500-2500m above sea level. Toona sinensis and Toona tomentosa are not widely distributed in China, and they are sporadic in nature. They are over-exploited and naturally regenerated slowly. The number of Toona sinensis and Toona tomentosa decreases continuously, but their development potential is great. In recent years, more and more domestic scholars have carried out extensive research on Germplasm resources, genetic structure, plant physiology, breeding, cultivation, afforestation, medicine and chemical composition, and resource protection of Toona sinensis and Toona tomentosa in view of their excellent variety characteristics and the fact that they are facing endangerment. This paper combines the research progress of Toona tomentosa and Toona sinensis as a supplement to the related research of Toona sinensis of the same family and genus.

1. Introduction

With the increase of population, excessive deforestation, deforestation and wasteland are very common. Forest secondary biochemical, resources have been decreasing, habitats are fragmented, and the environment suiTable for the growth of Toona sinensis has been gradually reduced. Destruction of forests directly reduces the number of Toona sinensis, reduces the reproductive and living capacity of the population, and causes environmental prematurity [1-4]. Soil erosion and soil impoverishment have led to a fundamental deterioration of habitat conditions of Toona sinensis population and restricted its survival and development [5]. Studies on plant genetic characteristics and environmental impacts can reveal the genetic laws of provenances [6-9]. With the development of biology, especially genetics and molecular biology, the methods of detecting plant genetic diversity have been improved and perfected, from the initial phenotype variation to the later chromosome polymorphism and protein polymorphism, and finally to the present DNA polymorphism. [10-12]. Prospects for molecular genetic research of Toona sinensis, in view of the related research progress of Toona sinensis, it is imperative to carry out follow-up research. Further improve the seed tracking collection of superior trees to provide a basis for the analysis of phenotypic variation characteristics of seeds and fruits; the SSR molecular markers of Toona sinensis in four provinces in southern China have been obtained to calculate gene flow and alleles, analyze Nei's gene diversity index (H) and Shannon's information index (I); and analyze genetic diversity among provenances of Toona sinensis; Analysis of genetic structure of Toona sinensis. At the same time, the breeding research at molecular marker level [13-16] The size of plant population affects the life potential of the population. Small population size is one of the characteristics of endangered population. The natural reserved populations of Toona are very small, mostly scattered, and their regeneration ability is poor [17-20]. This paper combines the research progress of Toona tomentosa and Toona sinensis as a supplement to the related research of Toona sinensis of the same family and genus.

2. Brief Introduction to the Development of Toona sinensis and Toona tomentosa

Toona ciliata Roem. (Toona ciliata Roem.) is a deciduous or semi-deciduous tree of Meliaceae

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and Toona. It can be up to 35 meters high and 1 meter diameter at breast height; its bark is grayish brown. Toona sinensis is one of the precious timber tree species in China, known as mahogany in China. Key protected wildlife at the national level II (approved by the State Council on August 4, 1999). It has certain medicinal value. In addition, its trunk is straight, its crown is huge and its branches and leaves are luxuriant. It can be planted on hillsides, valleys, forests, rivers and villages, or on both sides of urban roads as street trees or yard trees. With the increase of population, excessive deforestation, deforestation and wasteland are very common. Forest secondary biochemical, resources have been decreasing, habitats are fragmented, and the environment suiTable for the growth of Toona sinensis has been gradually reduced. If not protected, it will be endangered. One of China's precious timber tree species, known as Chinese mahogany. Key protected wildlife at the national level II (approved by the State Council on August 4, 1999). Destruction of forests directly reduces the population size of Toona sinensis, reduces the reproductive and living capacity of the population, and causes environmental prematurity. Soil erosion and soil impoverishment led to the deterioration of habitat conditions of Toona sinensis population, which restricted the survival and development of Toona sinensis population. It has become an endangered plant with red-brown wood, beautiful patterns and tough texture. It is most suiTable for making high-grade furniture. The heartwood of Toona sinensis is dark reddish brown with light sapwood color, straight texture, fine structure, beautiful pattern, light and soft material, insect-proof and corrosion-resistant, fast drying, small deformation, easy processing, and good paint and adhesive properties. It is a good material for building, furniture, boat, plywood and interior decoration. The bark contains 11-18% tannin and can extract tannin extract.

Toona ciliata Roem. var. pubescens (Franch.) Hand. -Mazz.): bark light grayish brown, scaly longitudinal cracks; young branches pubescent, red when dry, sparsely brown dermal holes, leaf axes densely pubescent, lanceolate, ovate or oblong lanceolate, apex acuminate, base wedge to broad wedge, oblique, entire margin Upper glabrous or sparsely pubescent, especially denser veins; petioles softly hairy, panicles terminal, about as long as leaves, pubescent, white flowers with short pedicels; calyx very short, oblong, pubescent or ciliate; stamens equal in length to petals. Capsule long elliptic, with sparse pits, brown when wood is dry; seeds have wings at both ends, usually the upper wing is longer than the lower, flat wings, thin film. The flowering period is from May to June and the fruit ripening period is from November to December.

3. Physiological comparison between Toona sinensis and Toona tomentosa

3.1 Physiological Studies on Toona sinensis

Physiological studies on Toona sinensis have made considerable progress in recent years. Drought stress is the main direction of stress resistance research. Wu Jiyou et al. conducted drought stress tests on one-year-old potted seedlings of five clones of Toona sinensis in different periods in April of spring. Under severe stress (normal water cut-off for 17 days), the relative water content of leaves of seedlings of Toona sinensis clones was the lowest, and there was no significant difference in relative water content among different clones, while the chlorophyll content of seedling leaves was the highest. There was no significant difference in chlorophyll content among different clones, and the chlorophyll content of seedlings of the whole cycle of Toona sinensis showed a gradual increase trend. Under full light, 60% shading, 80% shading and three soil moisture treatments (high, medium and low), the characteristics of leaf net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration, chlorophyll content and leaf area of Toona tomentosa seedlings were studied. The results showed that the diurnal photosynthetic process of Toona tomentosa seedlings under full light and moderate shading in summer showed a "double peak" pattern. High light intensity and high temperature at noon promoted obvious photosynthetic "noon rest". Under the same light condition, the soil moisture content was proportional to the leaf area. Under shading conditions, Toona tomentosa seedlings can effectively utilize weak light radiation by increasing leaf area and chlorophyll content to form ecological survival strategies adapted to shading conditions.

The water stress test of clones of Toona sinensis seedlings showed that the clones with stronger drought resistance could be screened by changing trend of chlorophyll, MDA, proline content, SOD and POD activity in clones seedlings. According to the survival rate of cuttings, rooting rate and the growth of one-year-old seedlings in summer and autumn, it is a feasible method for breeding Toona sinensis. SOD and POD of leaves were significantly different in different clones and drought stress treatment gradients. Under moderate stress (12 days after normal watering), SOD content in leaves of seedlings of Toona sinensis clones was the highest (606.83U/g). There was no significant difference in SOD content in leaves of seedlings of different clones in different periods. POD content in leaves of seedlings under severe stress (17 days after normal watering) was the highest. There was no significant difference in POD content among clones, and the POD content in leaves decreased with the test period.

In the absence of trace elements, Toonaciliata M. Roemvar. australis is not conducive to height, diameter growth and dry matter accumulation. The most direct related effect is boron deficiency. Boron deficiency causes wilting of tender leaves, changes in bud and root morphology; manganese deficiency leaves roll up and show slight yellowing disease; copper deficiency leaves appear blue spots, leaves wither; zinc deficiency leads to shortening of internodes and smaller lanceolate leaves; iron deficiency leads to slow plant growth and yellowing of tender leaves. One-year-old potted seedlings of Toona sinensis grown in Acidic Purple soil, calcareous purple soil and alluvial soil in Southwest China were exposed to different concentrations of Pb stress (0, 200, 450 and 2000 mg/kg). Leaf length, leaf area, biomass, characteristics of Pb content and enrichment degree of organs were different. Toona sinensis had different tolerance to Pb pollution and transfer efficiency. Toona sinensis, as a fast-growing native timber species resistant to Pb pollution, has certain ability to absorb and enrich Pb. Therefore, Toona sinensis can be considered as a pioneer species for ecological remediation of Pb-contaminated soil in southwest China.

3.2 Development prospects of Toona sinensis and Toona tomentosa.

At present, the number of Toona sinensis in China changes as shown in Fig. 1.

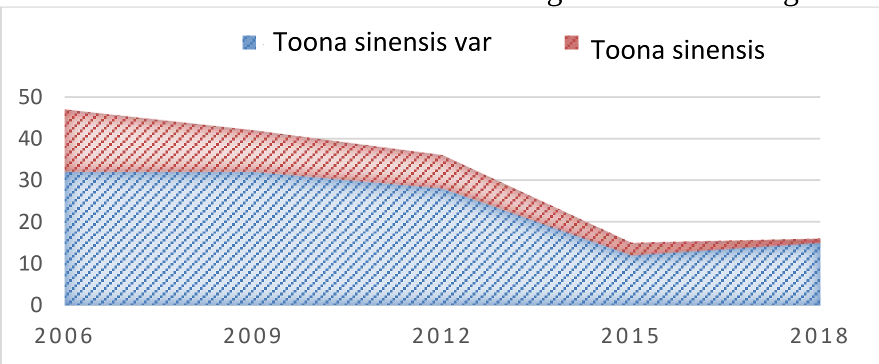

Fig. 1 Changes in the number of Toona sinensis

Further collecting excellent germplasm resources of Toona sinensis in natural distribution areas of different phenological regions, using seedlings from natural distribution areas of Toona sinensis in Hubei Province (including semi-sib families, clones and excellent stand families) to conduct breeding experiments, and to study seedling breeding techniques. To study scientific observation methods of seedling traits of Toona sinensis, such as germination rate, seedling height, ground diameter, phenology and growth rhythm, seedling overwintering mortality and injury rate, physiological indicators such as photosynthetic rate, respiratory intensity, chlorophyll content, CO2 intercellular concentration, drought stress, and so on, establish seedling technical evaluation system of Toona sinensis provenance test.

4. Comparison of genetic effects between Toona sinensis and Toona tomentosa

4.1 Geographical impact.

Due to environmental changes, over-exploitation and slow natural regeneration, the number of

Toona tomentosa has been decreasing. In addition to natural forest distribution in Jiangxi, Yunnan, Anhui and Zhejiang provinces, Toona tomentosa has only sporadic distribution Table 1 in other provinces. Table 1 shows the geographical location and climatic distribution of Toona sinensis.

The climate in the distribution area of Toona tomentosa is the tropical monsoon climate in Central and South Asia. Toona tomentosa likes sunshine and grows fast. The distribution area of Toona tomentosa is mostly mountainous and hilly. The phenotypic variation of Toona tomentosa was analyzed, including flowering, fruit, leaf, fruit, seed and seedling. There were significant differences in petiole length, leaf length, leaf width and leaf length/leaf width among populations. Capsule size varies greatly among different populations, and Yifeng population is the largest. The 100-seed weight of Toona tomentosa seeds is very small, and the seeds have wings on both sides, which is conducive to seed transmission. The eight traits of seedling height, ground diameter, root dry weight, stem dry weight, rhizome ratio, total root length, root surface area and root volume were significantly different among families, which indicated that there were abundant variations among the offspring of Toona tomentosa and had breeding potential.

Table 1 Geographical location and climatic conditions of Toona sinensis

Name	**Sampling number**	**Number of test samples**	**Longitude (E) Dimension (N)**	**altitude /m**	**Annual average temperature /C °**	**humidity /%**
Jiangxi (Guanshan)	30	20	114°35’/28°37’	700	16	85
Yunnan(Dali)	30	20	100°08’/25°40’	1978	20	90.2
Anhui (Fuyang)	30	20	115°48’/32°36’	33	15.2	58
Zhejiang (Shaoxing)	30	20	120°34’/30°01’	11.19	19.8	76

4.2 Gene research.

Genomic DNA was extracted from fresh leaves of Toona tomentosa by modified CTAB method. The microsatellite DNA fragments of Toona tomentosa genome were captured by the improved chain-parent Toona tomentosa bracted to be placed and the affinity method of plain magnetic beads, and a microsatellite-rich genomic library was constructed. Sixty-three monoclones were randomly selected from the constructed genomic library for sequencing, of which 50 were successfully sequenced and 17 contained microsatellites. Sequencing results were used to design and synthesize 17 pairs of SSR primers.

4.3 Genetic diversity.

Eight pairs of microsatellite markers were used to study the genetic diversity of eight natural populations of Toona tomentosa distributed in China. The results showed that the natural population of Toona tomentosa had a low level of genetic diversity. The average number of alleles, effective alleles and expected heterozygosity were 6.4, 2.8 and 0.61 respectively. The variation of Toona tomentosa population mainly comes from within the population, and the differentiation among populations is large. The average genetic differentiation coefficient (ST) is 0.2029. Based on the F_ (ST) value, the estimated gene flow among populations of Toona tomentosa is 0.9821, which indicates that the level of gene flow among populations is low. Eight populations were clustered by mean distance method (UPGMA), and eight populations were divided into three subgroups.

4.4 Spatial genetic structure.

Eight pairs of microsatellite DNA were used to study the spatial genetic structure of three natural populations of Toona tomentosa distributed in China. 209 individual plant materials from three natural populations of Toona tomentosa were collected and the location of each individual plant was located. The spatial genetic structure of Toona tomentosa population was studied by spatial autocorrelation analysis to guide the formulation of conservation strategies. Spatial autocorrelation analysis revealed that there was a spatial genetic structure in the natural population of Toona tomentosa Yifeng, while the genetic variation of alleles in Shizong and Binchuan populations was random in space, and there was no obvious spatial genetic structure. The reasons for the formation of spatial genetic structure in Yifeng population include limited seed transmission, microenvironment heterogeneity and population density.

5. Conclusion

The genetic variation of Toona sinensis mainly existed among provenances, and the fruit length-width ratio, fruit length, 1000-seed weight and seed length traits were strongly controlled by heredity. Geographical variation of all traits was mainly meridional, and correlated with annual minimum temperature, annual maximum temperature and frost-free period of seed collection sites. From Eastern China (central and Eastern China) to Western China (southwest and southern China), the area, length and width of leaflets, seed and fruit traits are gradually decreasing, and the 1000-grain weight and fruit length of seeds decrease with the increase of annual maximum temperature. With the lowest temperature decreasing, the characters of leaves, seeds and fruits decreased; with the prolongation of frost-free period, the leaves became narrower and smaller, the seeds became smaller, the 1000-grain weight decreased, and the fruits became smaller; the size of leaves, seeds and fruits showed a very significant positive correlation, showing that certain vegetative growth contributed to reproductive growth. According to the above research results, the main reasons for endangerment of Toona tomentosa include habitat fragmentation, over-exploitation and slow natural regeneration. On this basis, the corresponding protection strategies for the existing population of Toona tomentosa are put forward as follows: Strengthen management, actively carry out research on the species, strengthen habitat detection, ex-situ protection, protection of rare resources and take certain conservation measures: (1) Strengthen propaganda work, enhance protection awareness; (2) In-situ conservation; (3) ex-situ preservation; (4) long-term scientific research and monitoring.

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