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主　論　文　の　要　旨

論文題目	Nondestructive spectroscopic research for fast growing hybrid wood （ハイブリッド早生樹の非破壊分光分析に関する研究）
氏　　名	DANG Duc Viet

論　文　内　容　の　要　旨

Plants of the genus Acacia are an important resource in global furniture manufacturing and are vital to the wood industry of Southeast Asian countries. Improvements in technology and tree breeding techniques have increased the interest in *Acacia* products. An Acacia hybrid (*Acacia mangium* x *Acacia auriculiformis*) was first recognized in 1972; since then, this hybrid has rapidly become an important tree in the industrial output of many countries, including Vietnam. Recently, *Acacia* hybrid plantation productivity and quality have been improved by using both cutting and tissue culture breeding technologies effectively in a large-scale clonal forestry. Research into breeding technologies has led to innovations in forestry and created cutting-edge methodologies, such as the breeding of polyploid *Acacia* hybrids.

In the present study, the physical and mechanical properties of polyploid *Acacia* (3x and 4x) clones with those of diploid (2x) clones grown in Vietnam were evaluated. There were 29 trees aged 3.8 years from different taxa were selected randomly for investigation. BV10 and BV16 clones represented the diploid controls; X101 and X102 were the triploid clones; and AA-4x, AM-4x, and AH-4x represented neo-tetraploid families of *Acacia auriculiformis, Acacia mangium,* and their hybrid clones. The following metrics were measured in each plant: stem height levels, basic density, air-dry equilibrium moisture content, modulus of rupture (MOR), modulus of elasticity (MOE), compression strength, and Young's modulus. The result showed that the equilibrium moisture content significantly differed among clones, and basic density varied from pith-to-bark and in an axial direction. In addition, the basic density of AA-4x was significantly higher than that of the

control clones. Furthermore, the MOR of AM-4x was considerably lower than the control clones, whereas the MOE of X101 was significantly higher than the control values. The compression strength of AM-4x was significantly lower than that of the control clones, but AH-4x had a significantly higher Young's modulus. The results suggest that polyploid *Acacia* hybrids have the potential to be alternative species for providing wood with improved properties to the forestry sector of Vietnam. Furthermore, the significant differences among the clones indicate that opportunities exist for selection and improvement of wood quality via selective breeding for specific properties.

The variation of wood properties for *Acacia* hybrid with rapid methods has still challenged for breeding program application. In this study, nine *Acacia* hybrid clones including diploid, triploid, and tetraploid were tested by near-infrared spectroscopy (NIR) and hyperspectral imaging (HSI). 1187 samples for specific gravity (SG) and air-dry moisture content (MC), 327 samples for bending test, and 521 samples for compression properties were collected. The standard normal variate (SNV) and 2^{nd} derivative (SP2D) were applied to compare the performance of NIR and HSI in partial least square regression. The images were acquired by HSI at a wavelength from 1033 to 2230 nm with SNV and SP2D were described the variation of wood properties. Moderate predictive ability was found for both NIR and HSI. The NIR predicted SG and MC better than HSI while NIR and HSI predicted mechanical properties similarly. The mapping results showed that the low density around the pith area and high density near the bark. It is also revealed that MC changing in a different position in one disk and depends on the position in the tree. Overall, NIR and HSI were proved the potential for prediction in wood properties for tree improvement program.

HSI spectra which obtained from SG, MC samples were used to identify 9 clones of *Acacia* wood. The pre-treatments were SNV and SP2D. The principal component analysis was applied in classification method. Then, we apply convolutional neural networks to HSI data to construct a protocol that can automatically identify 1187 samples into 9 species with a nondestructive and rapid manner. After that, the light absorption from HSI data were compressed into principle components (PC) scores to facilitate the analysis of deep learning. Finally, deep learning prediction models based on PC images from HSI spectra were built and compared with identification results using HSI with the same pre-treatments. Deep learning results demonstrated that the accuracy of species identification based on HSI was 84%, and this improved to 91% using 6PC images obtained from NIR hyperspectral images. Deep learning proved to be useful for wood analysis base on the HSI contribute to better prediction than the result of using only HSI.