

## ABSTRACT

*Gyrinops versteegii* is one of the good agarwood-producing trees of the Thymelaeaceae family threatened by uncontrolled logging (overcutting). For preventing its extinction, this species was included in appendix II CITES and it was widely domesticated by stakeholders. Several agroforestry practices have been deliberately selected for domesticating this species due to their benefit both economic and environmental services such as carbon sequestration from the atmosphere. The objectives of the research are: (1) to study deeply the growth of *G.versteegii* and its site characterization in several agroforestry practices; (2) to study deeply the storage and sequestration carbon; (3) to study the effect of inoculum kind and inoculation techniques on forming the agarwood.

The research was carried out in the agroforestry practices i.e: multilayer tree garden in Sragen, taungya and home garden both in Karanganyar District. Purposive sampling was selected to take the sample using a permanent plot utilizing a nested plot model. Plot size of  $1 \times 1 \text{ m}^2$  was used for undergrowth vegetation and seedling;  $5 \times 5 \text{ m}^2$  for sapling;  $10 \times 10 \text{ m}^2$  for pole; and  $20 \times 20 \text{ m}^2$  for trees. Soil sampling and environmental factor measurements were regularly held at a diagonal intersection plot of  $20 \times 20 \text{ m}^2$ . As a parameter of Environmental factors of the research were air temperature, humidity, light intensity, soil chemistry, and soil texture. Soil analysis was conducted at Instiper's central laboratory. Furthermore, undestructive and destructive methods were used for carbon measurement not only of which on the above ground but also underground. The former was utilized for measuring undergrowth vegetation, litter, and necromass, and the later was used for the trees. In addition, a split-split plot design in a randomized block design was used for doing inoculation research. The microbe which has three levels was the main plot (whole plot); the position of the hole at the stem as a subplot, and the inoculation techniques as a sub-subplot. All of the treatments have three levels, so the total number of treatment was  $3 \times 3 \times 3 = 27$  treatment combinations. The analysis of terpenoid was conducted at Gadjah Mada University's organic chemistry laboratory, and both the wood color analysis and the olfactory analysis were held at the Instiper Campus. The research was done for 18 months (April 2017-October 2018). Then, the data was accurately analyzed by using SPSS software version 22.

The results of this research are (1) *G.versteegii* tree was successfully domesticated in several agroforestry practices not only in Sragen but also in Karanganyar District. The multilayer tree garden gives the greater of the height and diameter growth of the 13-year-old *G.versteegii* tree compared to that growth in the

taungya and home garden. The environmental factors influencing the *G.versteegii* growth are air temperature, air humidity, light intensity, C / N ratio, P element, Mg element, Cation Exchange Capacity (CEC), density and soil texture. (2) Agroforestry practices based agarwood (*G.versteegii*) tree can potentially provide environmental benefits in the form of deposit and sequestration of carbon. The multilayer tree garden has not only greater carbon sequestration but also carbon stock both at above ground and underground. The amount of carbon sequestration is largely determined by climates such as the wet season, the structure and composition of the vegetation community, the diameter of the tree, and the wood specific gravity of the tree. (3) Bio-induction of *G.versteegii* tree with inoculating *Fusarium oxysporum*, *F. solani*, and *F. oxysporum* x *F. solani* at several agroforestri practices responded to the formation of agarwood. The treatment combination among *F. oxysporum*, infusion inoculation technique and the position of the inoculation hole at the top of the stem have yielded the best quality and quantity of agarwood which characterized by wood color, discoloration area, wood aroma, and terpenoids compound content.

## INTISARI

*Gyrinops versteegii* merupakan salah satu jenis pohon penghasil gaharu kualitas terbaik dari family *Thymelaeaceae*, yang terancam punah akibat penebangan yang tidak terkendali (*overcutting*). Untuk mencegah kepunahannya, jenis ini dimasukkan dalam *CITES appendix II*, dan dilakukan domestikasi oleh beberapa *stakeholders*. Domestikasi jenis dilakukan dengan beberapa praktik agroforestri karena akan mendapatkan keuntungan baik secara ekonomi maupun jasa lingkungan dalam bentuk penyerapan karbon dari atmosfer. Tujuan penelitian ini adalah: (1) untuk melakukan kajian terhadap pertumbuhan *G.versteegii* dan karakterisasi tapak pada beberapa praktik agroforestri; (2) untuk mengkaji simpanan dan serapan karbon di lahan agroforestri berbasis gaharu; (3) untuk mengkaji pengaruh inokulum dan teknik inokulasi terhadap pembentukan gubal gaharu pada beberapa praktik agroforestri.

Penelitian dilakukan di tiga praktik agroforestri yaitu kebun campur berada di kabupaten Sragen, taungya, dan pekarangan keduanya berada di Kabupaten Karanganyar. Pengambilan sampel dilakukan secara *purposive sampling*, dengan pembuatan plot permanen dengan model *nested plot*. Plot ukuran 1 x 1 m<sup>2</sup> untuk tumbuhan bawah dan semai, 5 x 5 m<sup>2</sup> untuk tingkat sapihan, 10 x 10 m<sup>2</sup> untuk tingkat tiang, dan 20 x 20 m<sup>2</sup> untuk tingkat pohon. Pengambilan sampel tanah dan pengukuran faktor lingkungan dilakukan dititik perpotongan diagonal plot 20 x 20 m<sup>2</sup>. Faktor lingkungan yang diukur suhu udara, kelembapan udara, intensitas cahaya, kimia tanah dan tekstur tanah. Analisis tanah dilakukan di laboratorium sentral Instipen. Metode yang digunakan untuk pengukuran karbon adalah *undestructive method* untuk tingkat pohon dan digunakan *destructive method* untuk tumbuhan bawah, litter dan necromass. Adapun rancangan penelitian yang digunakan untuk penelitian inokulasi adalah *split-split plot* dalam rancangan acak kelompok (RAK). Sebagai petak utama (*whole plot*) adalah mikroba, posisi lubang dalam batang sebagai *sub plot*, dan teknik inokulasi sebagai *sub-sub plot*. Jumlah kombinasi perlakuan 3x3x3= 27 kombinasi perlakuan. Analisis kandungan terpenoid dilakukan di laboratorium kimia organik Universitas Gadjah Mada. Analisis warna kayu digunakan software colormeter, analisis olfactory dilakukan di Kampus Instipen. Penelitian dilakukan selama 18 bulan, mulai dari April 2017-Oktober 2018. Data dianalisis dengan komputasi menggunakan software SPSS versi 22.

Hasil penelitian ini adalah (1) Pohon *G.versteegii* ternyata berhasil didomestikasikan di beberapa tempat tumbuh di Sragen dan Karanganyar Jawa Tengah melalui pertanaman campuran dengan jenis lain. Praktik agroforestri kebun campur memberikan pertumbuhan tinggi dan diameter pohon *G.versteegii* umur 13 tahun relatif lebih baik dibandingkan dengan praktik agroforestri taungya dan pekarangan. Faktor lingkungan yang berpengaruh terhadap pertumbuhan *G.versteegii* adalah suhu udara, kelembapan udara, intensitas cahaya, rasio C/N, kandungan unsur P, unsur Mg, Kapasitas Pertukaran Kation (KPK) tanah, kerapatan dan tekstur tanah. (2) Praktik agroforestri berbasis gaharu (*G.versteegii*) dapat memberikan manfaat jasa lingkungan berupa simpanan dan serapan karbon yang sangat potensial. Praktik agroforestri kebun campur dapat memberikan simpanan dan serapan karbon

di atas tanah lebih besar dibandingkan dengan praktik agroforestri taungya dan pekarangan. Besar kecilnya serapan karbon sangat ditentukan oleh musim (bulan basah), struktur dan komposisi komunitas, diameter pohon, dan berat jenis pohon. (3) Inokulasi pohon *G.versteegii* dengan menggunakan inokulum jamur *Fusarium oxysporum*, *F. solani*, dan campuran jamur *F. oxysporum* x *F. solani* pada berbagai paraktek agroforestri dapat merespon terbentuknya gubal gaharu. Inokulasi dengan menggunakan inokulum jamur *F. oxysporum* dengan teknik infus dan posisi lubang inokulasi pada bagian atas batang di praktik agroforestri taungya memberikan hasil kualitas dan kuantitas gaharu relatif lebih baik dibandingkan dengan di praktik agroforestri kebun campur dan pekarangan yang ditunjukkan oleh warna kayu, luas diskolorasi, aroma kayu dan kandungan senyawa terpenoids.