



UNIVERSITI PUTRA MALAYSIA

***CARBON STOCK AND GROWTH PERFORMANCE OF DIFFERENT
KENAF (*Hibiscus cannabinus* L.) VARIETIES IN BRIS SOIL OF
DIFFERENT ORGANIC CARBON LEVELS***

MD. DELWAR HOSSAIN

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By

MD. DELWAR HOSSAIN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirement for the Degree of Doctor of Philosophy**

June 2012

DEDICATION

This thesis is dedicated to my parents, brothers, sisters, wife, and daughter, who made a lot of sacrifice for me.

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Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for Doctor of Philosophy

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Chairman : Professor Mohamed Hanafi Musa, PhD

Institute : Tropical Agriculture

High interest in growing kenaf throughout the world is due to its high biomass yield, elevated fiber contents, and as good carbon (C) sequesters plant. Soil fertility management is a pre-requisite for successfully growing kenaf in marginal soil. Hence, the overall objectives were (i) to determine the optimum levels of N, P, and K for optimum growth of kenaf, (ii) to evaluate the effects of different C levels and sources on the growth, biomass production, physiological traits, fiber yield, fiber morphological traits and C stock by the kenaf plants and soil, (iii) to study the root characteristics of kenaf varieties and to relate the shoot growth to root traits of different varieties, and (iv) to determine the effects of C levels on kenaf under field conditions. The optimum levels of major nutrients, N, P, and K, were obtained by growing V36 kenaf variety in polypropylene trays containing aerated Hoagland's nutrient solution using five different concentrations. Plants grown under N, P, and K deprivation showed significantly lower growth, biomass production, chlorophyll

content, photosynthesis and stomatal conductance. The highest values for these parameters were obtained from 200 N, 100 P, and 100 K (in mg L⁻¹) and then declined. The effects of different C levels and sources on the growth, biomass production, physiological traits, fiber yield, fiber morphological traits and C stock by the kenaf plants and soil were evaluated in the glasshouse. The maximum values of these parameters were achieved at 20 t ha⁻¹ C level. The variety HC2 accumulated the highest dry matter followed by V36. Most of the dry matter accumulation occurred in stems (63.98%). Of the five varieties, the average dry matter in stems was 76.83% and in leaves was 20.56%. The macro- and micro-nutrients proportion varied markedly in plant components and varieties. The kenaf varieties exhibited significant variation in fiber length, width, lumen width, and cell wall thickness. The maximum C stock was observed for variety HC2 and at 20 t ha⁻¹ C level. The root growth, total root length, number of root tips, root surface area and root volume showed significant differences in their responses to C levels in pot experiment. The varieties, producing higher shoot growth, were associated with the higher values of root traits. The effects of C levels on kenaf were investigated under natural field condition for two seasons. Kenaf plants cannot generate vigorous plants growth under zero C level. The differences in plant growth, physiological parameters, proportions of macro- and micronutrients and total nutrients accumulated in the plant components, yield, fiber morphological dimensions and C stock suggested that the variety HC2 as well as V36 could be considered as the appropriate varieties to be grown on BRIS soil under effective management of organic C.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk mendapat Ijazah Doktor Falsafah

**STOK KARBON DAN PRESTASI PERTUMBUHAN VARIETI KENAF
(*Hibiscus cannabinus* L.) YANG BERBEZA DI TANAH BRIS YANG DENGAN
TAHAP KARBON ORGANIK YANG BERBEZA**

Oleh

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Kepentingan yang tinggi dalam penanaman kenaf di seluruh dunia adalah disebabkan hasil biomass yang tinggi, serat kandungan fiber yang tinggi, dan sebagai tumbuhan yang berkesan bagi pengasingan karbon (C). Pengurusan kesuburan tanah adalah satu pra-syarat bagi pertumbuhan kenaf di tanah marginal. Maka, keseluruhan objektif adalah (i) Bagi menentukan tahap optimum nutrient utama, N, P, dan K untuk pertumbuhan kenaf optimum, (ii) untuk menilai kesan-kesan perbezaan tahap karbon dan sumber-sumber untuk pertumbuhan, pengeluaran biojisim, ciri-ciri fisiologi, hasil fiber, ciri-ciri morfologi fiber dan pemencilan karbon oleh tanaman kenaf dan tanah, (iii) untuk mengkaji ciri-ciri akar varieti kenaf dan berkait dengan pertumbuhan pucuk kepada ciri-ciri akar berlainan variety (iv) bagi menentukan kesan tahap C ke atas kenaf dalam eksperimen lapangan. Tahap optimum nutrient utama, N, P, dan K, diperoleh melalui pertumbuhan varieti kenaf V36 ditanam di dulang polipropylene yang mengandungi larutan nutrient berudara Hoagland menggunakan lima kepekatan yang berbeza. Tumbuhan yang ditanam dalam keadaan kekurangan N, P, dan K

menunjukkan pertumbuhan lebih rendah, pengeluaran biojisim, kandungan klorofil, fotosintesis dan kealiran stomatal. Nilai tertinggi bagi parameter-parameter ini diperolehi dari 200 N, 100 P, dan 100 K (dalam mg L⁻¹) dan kemudian menurun. Kesan-kesan perbezaan tahap karbon dan sumber-sumber untuk pertumbuhan, pengeluaran biojisim, ciri-ciri fisiologi, hasil fiber, ciri-ciri morfologi fiber dan stok karbon oleh tanaman kenaf dan tanah dinilai di dalam rumah kaca. Nilai maksimum parameter-parameter ini telah dicapai pada tahap 20 t ha⁻¹ C. Varieti HC2 mengumpulkan bahan kering tertinggi dan diikuti V36. Kebanyakan pengumpulan bahan kering berlaku dalam stem (63.98%). Antara lima varieti, purata bahan kering dalam stem ialah 76.83% dan dalam daun ialah 20.56%. Bahagian makro dan mikro-nutrien berubah ketara dalam komponen dan varieti. Pengasingan maksimum C diperhatikan untuk varieti HC2 dan pada tahap 20 t ha⁻¹ C. Pertumbuhan akar, jumlah panjang akar, bilangan tips akar, permukaan akar, dan isipadu akar menunjukkan perbezaan ketara dalam tindak balas terhadap tahap C pada eksperimen pasu. Varieti menghasilkan pertumbuhan pucuk lebih tinggi yang berkaitan dengan nilai ciri-ciri akar lebih tinggi. Kesan tahap C pada kenaf dikaji dalam situasi semulajadi bagi dua musim. Keputusan menunjukkan kenaf tidak boleh menjana pertumbuhan tumbuhan bawah tahap C sifar. Perbezaan dalam pertumbuhan kenaf, ciri-ciri fisiologi, bahagian makro dan mikro nutrient dalam komponen tanaman kenaf, hasil fiber, ciri-ciri morfologi fiber dan stok karbon dalam keadaan kajian ruma kaca dan lapangan mencadangkan bahawa varieti HC2 dan V36 boleh dianggap sebagai varieti yang paling sesuai untuk ditanam di tanah BRIS di bawah pengurusan C organik yang berkesan.

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I certify that a Thesis Examination Committee has met on 12 June 2012 to conduct the final examination of Md. Delwar Hossain on his Doctor of Philosophy thesis entitled “Carbon Stock and Growth Performance of Different Kenaf (*Hibiscus cannabinus* L.) Varieties on BRIS Soil as Influenced by Different Organic Carbon Levels” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MD. DELWAR HOSSAIN

Date: 12 June 2012

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