



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON BRIS FERTILITY
AND GROWTH PERFORMANCE OF SELECTED KENAF (HIBISCUS
CANNABINUS L.) VARIETIES**

MOHD HADI AKBAR BIN BASRI

FH 2014 5



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(*HIBISCUS CANNABINUS* L.) VARIETIES**

By

MOHD HADI AKBAR BIN BASRI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Science**

June 2014

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DEDICATION

*Especially to whom their love and support behind my
fulfillment of this study:*

My father, Basri Bin Hj. Wasli,

My mother, Rosmah Binti Abdullah,

My sisters and brothers,

My fiancée,

Noorsuhaila Binti Abu Bakar,

My friends,

Thank you and I love u all

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

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MOHD HADI AKBAR BIN BASRI

June 2014

Chairman : Assoc. Prof. Arifin Abdu, PhD

Faculty : Forestry

Kenaf (*Hibiscus cannabinus* L.) in Malaysia are widely planted on low fertility problematic soil known as Beach Ridges Interspersed with Swales (BRIS). BRIS soils have low nutrient concentration, low fertility, and lacks of many important soil properties that affects the yield and productivity of kenaf. Therefore, in the first study, a pot experiment was carried out to determine and compare the effects of biochar, chicken manure, urea and zeolite on soil pH variability and elevation in a sandy loam acidic soil. Fan and Mackenzie's method was modified and used to determine the soil pH in the pots. Soil pH in the pots was measured using a glass micro-electrode and spatial variability was interpolated and mapped using GIS software. Kriged maps clearly showed the presence of variability and elevation in pH within each treatment. Furthermore, the position of patches with maximum and minimum values for pH changed between all treatments used in the experiment. The highest elevation was found in Zeolite treated soil followed by urea and biochar. However, a significant decrease was measured in soil pH in chicken manure treated soil. These findings could be the first step towards establishing temporal stability in the pattern of spatial distribution of soil pH affected by the soil amendments. A second study was conducted in a glasshouse experiment to determine the effects of mixed organic-inorganic fertilizer application on the properties of BRIS soils and the growth of *Hibiscus cannabinus* L. Altogether, there were 16 treatments: (T₁)-control (100% BRIS soil), (T₂)-NPK (chemical fertilizer), (T₃)-CM (chicken manure), (T₄)-B (biochar), (T₅)-Z (zeolite), (T₆)-NPK+CM, (T₇)-NPK+B, (T₈)-NPK+Z, (T₉)-CM+B, (T₁₀)-CM+Z, (T₁₁)-B+Z, (T₁₂)-NPK+CM+B, (T₁₃)-NPK+CM+Z, (T₁₄)-CM+B+Z, (T₁₅)-NPK+B+Z and (T₁₆)- NPK+CM+B+Z. Results showed that application of inorganic material or organic fertilizer in combination with chemical fertilizer (T₂ and T₁₆) improved soil fertility, which are reflected by the increase in exchangeable K, Ca and Mg, cation exchange capacity (CEC), total N, total C and available P. The highest level of kenaf growth was observed in T₁₅ treatment. Application of biochar, zeolite or chicken manure alone on the soils did not result in better kenaf growth compared to the

control. Zeolite and biochar should be applied with other fertilizers or organic substrates to obtain a positive crop yield and improve the soil properties. In addition, more studies of the application of chicken manure at different ratios should be conducted to obtain the best yield. A combination treatment, T₁₅ (NPK + biochar + zeolite) can be suggested to farmers, especially for cultivation of kenaf on sandy BRIS soil in order to obtain the best kenaf growth performance and indirectly reduce excessive use of chemical fertilizers. Optimization of the fertilizer rate for BRIS soils and selection of suitable soil amendments is crucial in these soils to obtain higher yields. Hence, in the third study a field experiment was conducted to evaluate optimization of fertilizers and their effects on soil chemical properties, physiology and the growth response of *Hibiscus cannabinus* L. cultivated on BRIS soils. Eight treatments were evaluated; (T₁) control, (T₂) biochar, (T₃) chicken manure, (T₄) urea, (T₅) chicken manure + urea, (T₆) biochar + chicken manure, (T₇) urea + biochar, and (T₈) biochar + chicken manure + urea. The biomass and physiological characteristics were recorded every month, while the soil was analyzed following standard laboratory procedure. The results showed that the application of organic and inorganic fertilizer (urea) significantly increased the nutrient content of the soil compared to the T₁ (control), T₃ (chicken manure) showed the highest mean values for pH, CEC, and exchangeable bases (Na, Mg, and Ca). In contrast, effects on growth measurement were found indicating that T₈ showed the highest mean values compared to other treatments. The physiological results showed that application of nitrogen fertilizer significantly increased the rate of photosynthesis and stomata conductivity. In conclusion, mixing of biochar with organic (chicken manure) and inorganic fertilizers (urea) improved the fertility of sandy soil and significantly showed the highest results in plant diameter, plant height and number of leaves. Further research and other related study are recommended in order to validate these findings.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN-KESAN BAJA ORGANIK DAN TAK ORGANIK KE ATAS
KESUBURAN BRIS DAN PRESTASI PERTUMBUHAN VARIETI KENAF
(*HIBISCUS CANNABINUS* L.) YANG TERPILIH**

Oleh

MOHD HADI AKBAR BIN BASRI

Jun 2014

Pengerusi : Prof. Madya Arifin Abdu, PhD

Fakulti : Perhutanan

Kenaf (*Hibiscus cannabinus* L.) di Malaysia ditanam dengan meluas di kawasan tanah yang mempunyai tahap kesuburan tanah yang rendah dikenali sebagai tanah endapan pasir laut yang terdapat di kawasan permatang pasir berselang seli dengan paya dan selari dengan pantai (BRIS). Tanah BRIS mempunyai kandungan nutrien yang rendah, kesuburan yang rendah, dan kekurangan banyak ciri-ciri penting tanah yang memberi kesan terhadap hasil dan produktiviti kenaf. Oleh yang demikian, kajian pertama telah dijalankan di dalam eksperimen pasu untuk menentukan dan membandingkan kesan-kesan biochar, tahi ayam, urea dan zeolite ke atas kepelbagaian pH tanah dan paras pH di dalam tanah asid loam berpasir. Kaedah Fan dan Mackenzie yang telah diubahsuai telah digunakan untuk menentukan pH tanah di dalam pasu. pH tanah di dalam pasu telah diukur dengan menggunakan elektrod kaca-mikro dan kepelbagaian ruang telah diselitkan dan dipetakan dengan menggunakan GIS + perisian lembut. Peta Kriged dengan jelas menunjukkan kehadiran kepelbagaian dan paras pH dalam setiap rawatan. Tambahan pula, kedudukan kawasan-kawasan dengan nilai pH yang maksimum dan minimum bertukar di antara semua rawatan yang digunakan di dalam eksperimen. Paras pH yang tertinggi telah dijumpai di dalam tanah dirawat dengan zeolite diikuti oleh urea dan biochar. Walaubagaimanapun, penurunan yang ketara telah diukur di dalam pH tanah dalam tanah yang dirawat dengan tahi ayam. Penemuan ini boleh menjadi langkah pertama ke arah kestabilan corak taburan kawasan pH tanah dipengaruhi oleh bahan pembaikan tanah. Kajian kedua juga telah dijalankan di dalam eksperimen rumah kaca untuk menentukan kesan-kesan aplikasi campuran baja organik-bukan organik ke atas ciri-ciri tanah BRIS dan pertumbuhan *Hibiscus cannabinus* L.. Terdapat 16 jumlah rawatan kesemuanya: (T₁)-kawalan (100% tanah BRIS), (T₂)-NPK (baja kimia), (T₃)-CM (tahi ayam), (T₄)-B (biochar), (T₅)-Z (zeolite), (T₆)-NPK+CM, (T₇)-NPK+B, (T₈)-NPK+Z, (T₉)-CM+B, (T₁₀)-CM+Z, (T₁₁)-B+Z, (T₁₂)-NPK+CM+B, (T₁₃)-NPK+CM+Z, (T₁₄)-CM+B+Z, (T₁₅)-NPK+B+Z dan (T₁₆)- NPK+CM+B+Z.

Keputusan menunjukkan aplikasi bahan bukan organik atau baja organik apabila digabungkan dengan baja kimia (T₂ dan T₁₆) telah menambah baik kesuburan tanah, di mana ia dipengaruhi oleh peningkatan dalam ketersediaan K, Ca, Mg, CEC, jumlah N, jumlah C dan ketersediaan P. Pertumbuhan kenaf yang tertinggi telah diperhatikan di rawatan T₁₅. Aplikasi biochar, zeolite, atau tahi ayam sahaja ke atas tanah tidak akan mencatatkan keputusan pertumbuhan kenaf yang lebih baik berbanding dengan rawatan kawalan. Zeolite dan biochar hendaklah diaplikasikan bersama dengan baja-baja yang lain atau substrat organik untuk mendapatkan hasil tanaman yang positif dan meningkatkan ciri-ciri tanah. Tambahan pula, lebih banyak kajian-kajian berkaitan aplikasi tahi ayam dalam nisbah yang berbeza hendaklah dijalankan untuk mendapatkan hasil yang terbaik. Kombinasi rawatan, T₁₅ (NPK + biochar + zeolite) boleh dicadangkan kepada petani-petani terutamanya penanaman kenaf di tanah BRIS berpasir supaya mampu mendapatkan prestasi pertumbuhan kenaf yang terbaik dan secara tidak langsung dapat mengurangkan penggunaan baja-baja kimia secara berlebihan. Pengoptimuman kadar penggunaan baja untuk tanah BRIS dan pemilihan pemindaan tanah yang sesuai adalah genting terutama pada tanah jenis ini untuk mendapatkan hasil yang tinggi. Oleh yang demikian, dalam kajian yang ketiga, eksperimen ladang telah dijalankan untuk menilai pengoptimuman baja-baja dan kesan-kesannya ke atas sifat-sifat kimia tanah, fisiologi dan reaksi pertumbuhan *Hibiscus cannabinus* L. yang ditanam di kawasan tanah BRIS. Tujuh rawatan telah dinilai; (T₁) kawalan, (T₂) biochar, (T₃) tahi ayam, (T₄) urea, (T₅) tahi ayam + urea, (T₆) biochar + tahi ayam, (T₇) urea + biochar, (T₈) biochar + tahi ayam + urea. Biojisim dan ciri-ciri fisiologi telah dicatatkan setiap bulan, manakala tanah telah dianalisa mengikut prosedur piawai makmal. Keputusan-keputusan menunjukkan aplikasi baja organik dan tak organik (urea) dengan nyata meningkatkan kandungan nutrien di dalam tanah berbanding dengan T₁ (kawalan), manakala T₃ (tahi ayam) menunjukkan nilai min tertinggi untuk pH, CEC, dan ketersediaan bes (Na, Mg, dan Ca). Untuk perbandingan, kesan-kesan ke atas pengukuran pertumbuhan menunjukkan T₈ mencatatkan nilai min tertinggi berbanding dengan rawatan-rawatan yang lain. Untuk kesan-kesan fisiologi, aplikasi baja nitrogen dengan nyata sekali menunjukkan peningkatan kadar fotosintesis dan pengaliran stoma. Kesimpulannya, campuran biochar dengan bahan organik (tahi ayam) dan baja tak organik (urea) memperbaiki kesuburan tanah berpasir dan dengan nyata sekali menunjukkan keputusan-keputusan yang tertinggi di dalam diameter tumbuhan, tinggi tumbuhan dan bilangan daun-daun. Walaubagaimanapun, kajian tambahan dan kajian lain yang berkaitan adalah digalakkan untuk mengesahkan penemuan ini.

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I certify that an Examination Committee has met on June, 20 2014 to conduct the final examination of Mohd Hadi Akbar Bin Basri on his Master of Science thesis entitled “Effects of Organic and Inorganic Fertilizers on BRIS Fertility and Growth Performance of Selected Kenaf (*Hibiscus cannabinus* L.) Varieties” 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 Master of Science.

Members of the Examination Committee were as follows:

Azmy Mohamed, PhD

Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Mohamad Azani Alias, PhD

Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Mohd Zaki Hamzah, PhD

Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Mohd Zaki Abdullah, PhD

Research Officer
Forest Research Institute Malaysia
(External Examiner)

NORITAH OMAR, PhD

Assoc. Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Arifin Abdu, PhD

Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Ahmed Osumanu Haruna, PhD

Associate Professor
Faculty of Agriculture and Food Sciences
Universiti Putra Malaysia Bintulu Campus
(Member)

BUJANG BIN KIM HUAT, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

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Name of Chairman of Supervisory Committee: Arifin Abdu, PhD

Signature: _____

Name of Member of Supervisory Committee: Ahmed Osumanu Haruna, PhD

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