UNIVERSITI PUTRA MALAYSIA

PERFORMANCE OF KENAF (Hibiscus cannabinus L.) GENOTYPES ANDTHEIR GENETIC VARIABILITY BASED ON DNA MICROSATELLITE MARKERS

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By

MAJID FOROUGHI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

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DEDICATIONS

Dedicated with Love to

My Kind Father, Mohammad Ali Foroughi

and

My Beloved Mother, Khorshid Abroi

For Their Endless Love, Support and Sacrifices

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

PERFORMANCE OF KENAF (*Hibiscus cannabinus* L.) GENOTYPES AND THEIR GENETIC VARIABILITY BASED ON DNA MICROSATELLITE MARKERS

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Chairman: Prof. Ghizan Bin Saleh, PhD

Faculty: Agriculture

Kenaf (*Hibiscus cannabinus* L.) is an annual fiber crop of the Malvaceae family and originated from the tropics of east and central Africa. It is a multipurpose crop for making pulp and paper, and biocomposites. A study was conducted to compare morphological and agronomic performances of 40 kenaf accessions grown on mineral soil in Serdang, Selangor and BRIS soil in Bachok, Kelantan Malaysia, to estimate heritability of important agronomic traits, to determine phenotypic correlations among the agronomic traits measured on those accessions, and to assess genetic diversity among the accessions using microsatellite (SSR) DNA markers.

In general, all the kenaf accessions performed better on mineral soil than they did on BRIS soil. Accession CQ3205 was found to be the best performing accession on mineral soil, but however, it did not perform significantly better than the control variety, V36.

Among the accessions evaluated on BRIS soil, IX51 was found to produce the highest fresh plant yield, fresh stalk yield, dry stalk yield, dry bast yield and dry core yield, which were significantly better than those of the control variety, V36. However, many accessions were found to have out-yielded the control variety on BRIS soil. Results of the analysis of variance showed significant genotype by location interaction for all traits measured, indicating severe influence of environmental factors, particularly the soil conditions, on performance of the accessions, for yield and its components at the locations. This has resulted in many cases high-yielding accessions in Serdang performed poorly in Bachok and *vice versa*.

Investigation of genetic diversity among the 40 kenaf accessions using four morphological and 16 agronomic traits revealed a wide range of variation. Results of ANOVA also showed significant variation for all the agronomic traits measured.

Genetic diversity among the accessions was also investigated using 10 microsatellite (SSR) markers. Results showed that SSRs were informative molecular markers for detecting genetic differences among kenaf genotypes, as indicated by the high Nei's gene diversity coefficient and polymorphic information content (0.55 and 0.50, respectively). Among the SSR primers amplified, Ht-18 and Ht-40 were found to be the most informative SSR markers to exhibit genetic variation among the accessions (with PIC values of 0.77 and 0.74, respectively).

Genetic similarity among the accessions obtained from amplification of the SSR markers was found to be low. The highest genetic similarity (0.73) was found between Accessions 15 and 7-1X, indicating similarity in the loci they possessed. In contrast, the SSR primers used revealed high level of dissimilarity (similarity coefficient of 0.00) between seven pairs of accessions *viz*., Ghana 07 and El Salvador, Cuba 797 and A63-478, G7 and El Salvador, Mahmur and A63-478, Mahmur and Everglade 71, G7 and Guatemala 4, and G7 and BG53-42. This indicates high genetic diversity between these pairs of accessions as they possessed dissimilar alleles at all the loci amplified.

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

PRESTASI GENOTIP KENAF (*Hibiscus cannabinus* L.) DAN KEPELBAGAIAN GENETIKNYA BERDASARKAN PENANDA DNA MIKROSATELIT

Oleh

MAJID FOROUGHI

Jun 2012

Pengerusi: Prof. Ghizan Bin Saleh, PhD

Fakulti: Pertanian

Kenaf (*Hibiscus cannabinus* L.) adalah tanaman fiber semusim dari famili Malvaceae dan berasal daripada kawasan tropika di Afrika timur dan tengah. Ia adalah tanaman seberguna yang digunakan untuk pembuatan pulpa dan kertas, dan biokomposit. Satu kajian telah dijalankan untuk membandingkan prestasi morfologi dan agronomi 40 aksesi kenaf yang ditanam di tanah mineral di Serdang, Selangor dan di tanah BRIS di Bachok, Kelantan Malaysia, untuk menganggarkan kebolehwarisan sifat-sifat agronomi penting, dan menentukan korelasi fenotip di antara sifat-sifat yang diukur pada aksesi tersebut, dan menilai kepelbagaian genetik antara aksesi menggunakan penanda DNA mikrosatelit (SSR).

Secara amnya, kesemua aksesi kenaf tersebut menunjukkan prestasi yang baik di tanah mineral berbanding yang ditanam di tanah BRIS. Aksesi CQ3205 dikenalpasti sebagai aksesi terbaik di tanah mineral namun prestasinya tidak melebihi varieti kawalan,V36 secara signifikan. Di tanah BRIS, IX51 didapati menghasilkan hasil pokok segar, hasil batang segar, hasil batang kering, hasil kulit kering dan hasil teras kering yang tertinggi di antara semua aksesi yang diuji, yang mana ianya lebih baik daripada varieti kawalan, V36 secara signifikan. Walau bagaimanapun, banyak aksesi yang diuji di tanah BRIS adalah lebih baik daripada varieti kawalan. Keputusan analisis varians menunjukkan interaksi antara genotip dan persekitaran yang signifikan bagi semua sifat yang diukur, membuktikan pengaruh faktor persekitaran yang kuat, khususnya keadaan tanah, terhadap prestasi aksesi, untuk hasil dan komponen-komponen hasil di lokasi. Ini telah menyebabkan dalam banyak keadaan, aksesi yang tinggi hasilnya di Serdang menunjukkan prestasi yang rendah di Bachok dan sebaliknya.

Penelitian kepelbagaian genetik di kalangan 40 aksesi kenaf menggunakan empat sifat morfologi dan 16 sifat agronomi menunjukkan julat variasi yang besar. Keputusan dari ANOVA telah menunjukkan variasi yang signifikan untuk semua sifat-sifat agronomi yang diukur.

Kepelbagaian genetik antara aksesi juga diteliti menggunakan 10 penanda mikrosatelit (SSR). Keputusan menunjukkan bahawa penanda SSR adalah penanda molekul yang informatif di dalam mengenalpasti perbezaan dari sudut genetik di antara aksesi kenaf, sebagaimana ditunjukkan oleh nilai pekali kepelbagaian gen Nei dan nilai kandungan

informasi polimorfik yang tinggi (masing-masing, 0.55 dan 0.5). Di antara penanda molekul SSR yang diamplifikasi, Ht-18 dan Ht-40 didapati sebagai penanda SSR yang paling informatif untuk menunjukkan variasi genetik antara aksesi (dengan nilai kandungan informasi polimorfik masing-masing 0.77 dan 0.74).

Kesamaan genetik antara aksesi yang diperolehi dari amplifikasi penanda SSR adalah rendah. Kesamaan genetik yang tertinggi (0.73) didapati di antara aksesi 17 dan aksesi 7-1X, menunjukkan kesamaan pada lokus-lokus yang dimiliki. Sebaliknya, primer SSR tersebut menunjukkan tahap ketidaksamaan yang tinggi (pekali persamaan 0.00) di antara tujuh pasangan aksesi berikut: Ghana 07 dan El Salvador, Cuba 797 dan A63-478, G7 dan El Salvador, Mahmur dan A63-478 , Mahmur dan Everglade 71, G7 dan Guatemala 4, dan G7 dan BG53-42. Ini membuktikan kepelbagaian genetik yang tinggi antara pasangan-pasangan aksesi yang disebutkan, kerana ia memperoleh alel-alel yang berlainan pada semua lokus yang diamplifikasi.

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I certify that a Thesis Examination Committee has met on 15 June 2012 to conduct the final examination of Majid Foroughi on his thesis entitled "Performance of kenaf (*Hibiscus cannabinus* L.) genotypes and their genetic variability based on DNA microsatellite markers" in accordance with the Universities and University Colleges Act 1971 and the Constitution of Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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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 institutions.

MAJID FOROUGHI

Date: 15 June 2012

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