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MORPHOLOGICAL, BIOCHEMICAL AND GENETIC DIVERSITY OF CUMIN FROM IRANIAN PROVINCES

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MORPHOLOGICAL, BIOCHEMICAL AND GENETIC DIVERSITY OF CUMIN FROM IRANIAN PROVINCES

By

ALIREZA BAHRAMINEJAD

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Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

MORPHOLOGICAL, BIOCHEMICAL AND GENETIC DIVERSITY OF CUMIN FROM IRANIAN PROVINCES

By

ALI REZA BAHRAMINEJAD

November 2011

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Faculty : Agriculture

In order to assess the genetic diversity of cumin and determine the traits effective on seed yield and cumin-aldehyde production, forty nine cumin ecotypes which are sub-populations belonged to nine populations from different provinces of Iran were evaluated based on morphological and biochemical traits. Results indicated a significant variation for all the measured traits among and within populations derived from different provinces. Kerman and Esfahan populations showed the best performance based on the phenotypic data, while Yazd had almost the lowest levels of traits. Correlation analysis showed number of seed per umbel and umbel per plant had highest relationship with seed yield. Path analysis also demonstrated that number of umbel per plant and number of seed per umbel had the most direct effects on seed yield and were identified as the most effective factors on seed yield. Cumin aldehyde was mostly correlated by number of umbel per plant. The present study showed that different qualitative characteristics such as seeds with light color and without trichome and leaves without trichome, alternate and large pods of petiole tend to produce high seed yield. Pattern analysis of different populations based on first two main principal components categorized the measured genotypes in to three groups:

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Pars, Northern_Khorasan, Golestan, Semnan and Yazd (Group1), Southern_Khorasan and Khorasan_Razavi (Group2) Kerman and Esfahan (Group3), where the third group are high yielding genotypes with different genetic background can be advised for cultivation and used in breeding programs. So the available genetic diversity among the Iranian cumin populations can be utilized to produce high yielding population of cumin.

Moreover the phenotypic diversity as well as molecular variability among the populations, a significant variation was seen within the populations. It proves that during the years so many variations due to sampling and also cross pollination as well as crossing over produce different ecotypes within each population some of the populations such as Kerman have shown more variability within the population. It can be due to higher evolution speed as compared to other populations. Therefore, there is a high potential for cumin breeding in Iran and introducing these ecotypes to other countries.

Cumin ecotypes showed different variation for the measured traits, the highest variation belonged to cumin-aldehyde. As these view Kerman and Esfahan populations had the best performance on cumin-aldehyde. Correlation analysis showed number of seed per umbel and umbel per plant had highest relationship with seed yield. Path analysis also demonstrated that number of umbel per plant and number of seed per umbel had the most direct effects on seed yield and were identified as the most effective factors on seed yield. Cumin aldehyde was mostly correlated by number of umbel per plant. The present study showed that different qualitative characteristics such as seeds with light color and without trichome and leaves without trichome, alternate and large pods of petiole tend to produce high seed yield. Evaluation of molecular variance using three joint molecular markers and phylogenic relationship of ecotypes was done for the first time. Within population

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variance showed the highest proportion of variation, the ecotypes in each population were different. AFLP markers showed more polymorphism than the other markers (RAPD and SSR). The highest PIC value belonged to E+AGT (0.66). Since this crop is cross pollinated and SSR is a codominat marker and AFLP has higher efficiency for assessing the polymorphism, using of SSR as well as AFLP can increase the impact of genetic survey. If genetic diversity is done based on a good coverage of AFLP & SSR markers in genome then the extreme genotypes based on distance can be chosen for hybrid production. Totally, based on all molecular markers clustering showed Yazd population has the biggest distance from the other populations, also Kerman and Khorasan populations which might have some ancestor had almost the close distance. Cluster of 49 cumin ecotypes, showed Zarand has arranged almost separately, it means that it may have different background than the others. The measured ecotypes were divided almost into five groups based on joint markers and comparison of phenotypic and molecular cluster therefore it can be confirmed that there is a good relation between the phenotypic and molecular clusters.

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Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

MORFOLOGI, BIOKIMIA DAN KEPELBAGAIAN GENETIK JINTAN DARI WILAYAH IRAN

Oleh

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Dalam rangka untuk menilai kepelbagaian genetik jintan dan menentukan sifat-sifat yang berkesan terhadap pengeluaran hasil biji dan jintan-aldehid, empat puluh sembilan ecotypes jintan yang terdiri dari populasi merangkumi sembilan populasi dari daerah yang berbeza di Iran dinilai berdasarkan ciri morfologi dan biokimia. Keputusan menunjukkan variasi yang signifikan untuk semua sifat yang diukur antara dan di dalam populasi yang berasal dari daerah yang berbeza. Populasi Kerman dan Esfahan menunjukkan prestasi terbaik berdasarkan data fenotipik, manakala Yazd menunjukkan tahap terendah sifat. Analisis korelasi menunjukkan jumlah biji pada umbel dan jumlah umbel pada tanaman mempunyai hubungan yang tertinggi dengan hasil biji. Analisis "path" juga menunjukkan bahawa jumlah umbel pada tanaman dan jumlah biji pada umbel mempunyai kesan langsung terhadap penghasilan biji dan dikenalpasti sebagai faktor yang paling berkesan dalam penghasilan biji. Aldehid jintan adalah berkorelasi dengan jumlah umbel pada tanaman. Kajian ini menunjukkan bahawa ciri-ciri kualitatif yang berbeza seperti biji dengan warna terang dan tanpa trichoma dan daun tanpa trichoma, bentuk alternatif dan "pods" yang besar cenderung menghasilkan jumlah biji yang tinggi. Pola analisis

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populasi yang berbeza berdasarkan dua komponen utama mengkategorikan genotip diukur kepada tiga kumpulan: Pars, Northern_Khorasan, Golestan, Semnan dan Yazd (kumpulan1), Southern_Khorasan dan Khorasan_Razavi (kumpulan2) Kerman dan Esfahan (kumpulan3), dimana kumpulan ketiga adalah terdiri dari genotip yang mempunyai hasil yang tinggi dengan latar belakang genetik yang berbeza dan boleh disarankan untuk program penanaman dan pembiakbakaan. Jadi kepelbagaian genetik yang ada di antara populasi jintan di Iran dapat digunakan untuk menghasilkan populasi jintan yang unggul.

Selain itu kepelbagaian fenotipik serta variabiliti molekul antara populasi, perbezaan ketara dapat dilihat di dalam populasi. Hal ini menunjukkan bahawa selama bertahun-tahun variasi kerana sampling dan juga pendebugaan kacuk serta persilangan ecotypes yang berbeza di dalam setiap populasi, sebahagian populasi seperti Kerman telah menunjukkan lebih variabiliti dalam populasi. Hal ini mungkin terjadi kerana kecepatan evolusi yang dibandingkan dengan populasi lain. Oleh kerana itu, ada potensi tinggi untuk pembiakbaikan jintan di Iran dan memperkenalkan germplasma ini ke negara lain.

“Ecotypes” jintan menunjukkan variasi yang berbeza untuk sifat-sifat yang diukur, variasi tertinggi adalah milik jintan-aldehid. Melalui pemerhatian populasi Kerman dan Esfahan mempunyai prestasi terbaik bagi jintan-aldehid. Analisis korelasi menunjukkan jumlah biji pada umbel dan jumlah umbel bagi setiap tanaman mempunyai kaitan yang tertinggi dengan hasil biji. Analisis “path” juga menunjukkan bahawa jumlah umbel pada tanaman dan jumlah biji pada umbel mempunyai kesan yang paling langsung terhadap penghasilan biji dan dikenalpasti sebagai faktor yang paling berkesan terhadap penghasilan biji. Aldehid jintan

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sebahagian besar adalah berkorelasi dengan jumlah umbel pada tanaman. Penyelidikan ini menunjukkan bahawa ciri-ciri kualitatif berbeza seperti biji dengan warna terang dan tanpa trichoma dan daun tanpa trichoma, bentuk alternat dan "pod" yang besar pada tangkai daun cenderung menghasilkan jumlah biji yang tinggi. Penilaian variasi molekul dengan menggunakan tiga penanda molekul bersama dan hubungan pertalian antara ecotypes dilakukan untuk pertama kalinya. Varians dalam populasi menunjukkan kadar variasi tertinggi, ecotypes dalam populasi masing-masing adalah berbeza. Penanda AFLP menunjukkan polimorfisme yang lebih berbanding penanda yang lain(RAPD dan SSR). Nilai PIC tertinggi adalah milik E+AGT (0.66). Kerana tanaman ini adalah hasil pendebungaan kacuk dan SSR merupakan penanda kodominan dan AFLP mempunyai kecekapan yang lebih tinggi untuk mengukur polimorfisma tersebut, penggunaan SSR serta AFLP dapat meningkatkan kesan daripada kajian genetik. Jika kepelbagaian genetik dilakukan berdasarkan liputan yang baik penanda AFLP & SSR di dalam genom maka genotip ekstrim berdasarkan jarak boleh dipilih untuk pengeluaran hibrid. Keseluruhannya, berdasarkan semua penanda molekul berkelompok menunjukkan populasi Yazd mempunyai jarak terbesar dari populasi lain, juga populasi Kerman dan Khorasan mungkin mempunyai pertalian rapat mempunyai jarak dekat. Kluster 49 ecotypes jintan, menunjukkan Zarand telah ditetapkan secara berasingan, itu bererti mungkin itu mempunyai latar belakang yang berbeza dari yang lain. Ecotypes yang diukur dibahagikan kepada lima kumpulan berdasarkan penanda bersama dan perbandingan kluster fenotip dan molekular dapat dipastikan bahawa terdapat hubungan yang baik antara kluster fenotip dan molekul.

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I certify that an Examination Committee has met on ……. To conduct the final examination of Ali Reza Bahraminejad on his Doctor of Philosophy thesis entitle "GENETIC DIVERSITY OF CUMIN IN IRAN AS DETERMINED BY MOLECULAR, BIOCHEMICAL AND MORPHOLOGICAL MARKERS" accordance with University Pertanian Malaysia (High Degree) Act 1980 and University Pertanian Malaysia (High Degree) Regulation 1981. The Committee recommends that the candidates be awarded the relevant degree. Member of the Examination Committee are 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 any other institution.

_____

ALIREZA BAHRAMINEJAD

Date: 16th November 2011

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