UNIVERSITI PUTRA MALAYSIA

GENETIC STUDIES AND BACKCROSS BREEDING FOR SHELF LIFE AND YIELD IN LONG BEAN (VIGNA SESQUIPEDALIS (L.) FRUW)

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Dedicated

to

My beloved parents

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract of dissertation submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy.

GENETIC STUDIES AND BACKCROSS BREEDING FOR SHELF LIFE AND YIELD IN LONG BEAN (*VIGNA SESQUIPEDALIS* (L.) FRUW)

By

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September, 1997

Chairman : Dr. Mohd. Said Saad

Faculty : Agriculture

A study was conducted on genetics of shelf life and yield characters of long bean. Four parental lines namely, L30, KU7, KU8 and CSL19 were used in the study. Genetic component analysis for shelf life and yield characters were done following generation mean analysis from four cross combinations namely Cross 1 (L30 X KU7), Cross 2 (L30 X KU8), Cross 3 (KU7 X KU8) and Cross 4 (L30 X CSL19). F_1, F_2 and backcross generations were developed. A study was also conducted to transfer genes for long shelf life from a donor parent (L30) to the genetic background of recurrent parent (KU7, KU8, CSL19) using backcross breeding method.

Results of scaling test showed that the additive-dominance model was adequate in explaining the genetic control of seeds per pod, seed weight, pod protein and seed protein in Cross 1; pod protein, seed protein and pod protein yield per plant in Cross 2; and shelf life in Cross 4. This study

revealed the importance of dominance gene effects, followed by dominance X dominance (l) interaction effects for shelf life and yield characters. The additive gene effect was proportionately small. Duplicate type of epistasis was observed in most of the characters including shelf life. Exploitation of heterosis breeding is suggested for the improvement of these traits having involved with non-additive gene effects. For characters which are under the control of additive (d) and additive X additive (i) gene interactions, simple selection procedure like pedigree method in the early generation is recommended.

The varied estimates of narrow-sense heritability among the crosses for different characters were due to genotype X environment interactions. Estimates of narrow-sense heritability for pod yield per plant and shelf life were high in Crosses 1 and 2, respectively. Shelf life and pod yield manifested high estimates of narrow-sense heritability in Cross 4.

The degree of heterosis varied with characters among the crosses, because of diverse geographical origin of the parental lines and the contributions of background genotypes through its interaction with segregating loci. Heterosis estimates were moderately high for shelf life and pod yield per plant in Cross 1, and low in Crosses 2, 3 and 4. Days to flower, days to harvest, moisture content and pod length showed negative heterosis among the crosses, indicating earliness of the hybrids, having less moisture content and reduced pod length.

Significant positive correlation between shelf life and pod yield was reported in Cross 4. Pod yield per plant was positively correlated with pods per plant, pod weight, pod protein and pod protein yield per plant. Days to harvest was negatively correlated with pod yield, pod protein, seed protein and pod protein yield per plant. Negative correlation between pod length and protein in the pods and seeds were also observed. Regression analysis showed that pods per plant, pod weight, pod protein, seed protein and pod protein yield per plant were the most important yield-contributing characters. Dry matter content, moisture content, pod length and pod weight were considered as highest contributing factors towards long shelf life.

The donor parent, L30, with long shelf life, was backcrossed to the recurrent parents KU7, KU8, and CSL19 to determine if the shelf life of the recurrent parent could be improved. Selection for long shelf life and yield characters was practiced between two generations of backcrossing. After two backcrosses, rapid progress was made in recovering the yield of the recurrent parent with long shelf life. Transgressive segregations found in the backcross generations could be successfully exploited in combining desired characters in a cultivar. No transgressive segregation was found for pod length, thus selection of acceptable pod length was effective. After selection for shelf life, the improvement of pod weight, pods per plant and pod yield were achieved in the BC_2F_1 generation. The results indicated that two

backcrosses were sufficient in combining long shelf life and high pod yield of long bean with acceptable pod length.

Abstrak disertasi ini dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi syarat memperolehi Ijazah Doktor Falsafah

KAJIAN GENETIK DAN PEMBIAKBAKAAN KACUKAN BALIK UNTUK JANGKA HAYAT SIMPANAN DAN HASIL KACANG PANJANG (*VIGNA SESQUIPEDALIS* (L.) FRUW)

Oleh

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Satu kajian ke atas genetik sifat jangka hayat simpanan dan hasil bagi tanaman kacang panjang telah dilakukan. Empat induk iaitu L30, KU7, KU8 and CSL19 telah digunakan. Analisis komponen gen dilakukan untuk sifat tersebut dengan menggunakan kaedah analisis min generasi ke atas empat kombinasi kacukan iaitu Kacukan 1 (L30 X KU7), Kacukan 2 (L30 X KU8), Kacukan 3 (KU7 X KU8) dan Kacukan 4 (L30 X CSL19). Generasi F_1, F_2 dan kacukan balik telah diperolehi. Kajian juga dilakukan untuk memindahkan gen untuk jangka hayat simpanan dari induk penderma (L30) kepada induk penerima (KU7, KU8, CSL19) dengan menggunakan kaedah kacukan balik.

Keputusan ujian pemeringkatan menunjukkan bahawa model additif-kedominan didapati mencukupi untuk menerangkan kawalan genetik bagi biji benih setiap lengai, berat biji benih; protein lengai dan protein biji benih

dalam Kacukan 1; kandungan protein lengai, kandungan protein biji benih dan hasil protein lengai bagi setiap pokok dalam Kacukan 2; dan jangka hayat simpanan dalam Kacukan 4, sebagaimana ditunjukkan oleh ujian pemeringkatan. Kajian ini juga menunjukkan kepentingan kesan gen dominan, diikuti kesan interaksi dominan x dominan (l) untuk sifat jangka hayat simpanan dan hasil lengai bagi setiap pokok. Sumbangan kesan gen penambah adalah sangat rendah. Epistasis jenis pendua didapati berlaku bagi kebanyakan sifat. Pembiakbakaan menggunakan heterosis adalah lebih sesuai untuk memperbaiki sifat seperti ini yang tidak dikawal oleh gen penambah. Untuk sifat-sifat yang tidak dikawal oleh gen penambah (d) dan interaksi penambah x penambah (l), prosedur pemilihan mudah seperti kaedah pedigri dalam generasi awal adalah disyorkan.

Keputusan yang berbeza bagi keterwarisan sempit antara kacukan untuk sifat-sifat berlainan adalah disebabkan oleh interaksi genotip x persekitaran. Nilai keterwarisan sempit untuk hasil lengai setiap pokok dan jangka hayat simpanan adalah tinggi dalam Kacukan 1 dan 2. Jangka hayat simpanan dan hasil lengai menunjukkan nilai keterwarisan sempit yang tinggi dalam Kacukan 4.

Nilai heterosis berbeza mengikut sifat berlainan pada tiap kacukan. Ini mungkin disebabkan oleh perbezaan geografi asal induk dan sumbangan latar genetik melalui interaksi dengan segregasi lokus. Nilai heterosis didapati sederhana tinggi untuk jangka hayat simpanan dan hasil lengai setiap pokok dalam Kacukan 1 dan rendah dalam Kacukan 2, 3 dan 4.

Jangkamasa untuk pembungaan, jangkamasa untuk penuaian, kandungan kelembapan dan panjang lengai menunjukkan heterosis negatif antara kacukan. Ini menunjukkan pokok hibrid yang matang awal mempunyai kandungan kelembapan yang rendah dan lengai yang pendek.

Korelasi positif yang bererti di antara jangka hayat simpanan dengan hasil lengai diperolehi dalam Kacukan 4. Hasil lengai sepokok menunjukkan korelasi positif dengan bilangan lengai sepokok, berat lengai, kandungan protein lengai dan protein lengai sepokok. Jangkamasa penuaian didapati mempunyai korelasi negatif dengan hasil lengai, protein lengai, biji benih lengai dan hasil protein lengai sepokok. Korelasi negatif juga diperolehi antara panjang lengai dengan kandungan protein lengai dan biji benih. Analisis regresi menunjukkan bilangan lengai setiap pokok, berat lengai, protein lengai, protein biji benih dan hasil protein lengai sepokok merupakan penyumbang utama kepada hasil. Berat kering, kandungan kelembapan, panjang lengai dan berat lengai merupakan penyumbang tertinggi untuk jangka hayat simpanan.

Induk penderma L30 dengan jangka hayat simpanan yang panjang telah dikacuk-balik dengan induk berulang KU7, KU8 dan CSL19 untuk menentukan samada jangka hayat simpanan induk berulang boleh diperbaiki sambil mengekalkan sifat asalnya. Pemilihan ke atas jangka hayat simpanan yang panjang dan sifat hasil dilakukan di antara dua generasi kacukan balik. Selepas dua kali kacukan balik, perkembangan pesat telah ditunjukkan dalam mendapatkan kembali hasil induk berulang dengan mempunyai