



UNIVERSITI PUTRA MALAYSIA

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

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FP 1997 11

Dedicated

to

My beloved parents



ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Dr. Mohd. Said Saad, the chairman of my supervisory committee, for his valuable advice, guidance and support during the course of the study. I am also grateful to him for his constructive suggestions and the time spent on supervising the research work.

My special thanks to Prof. Dr. Yap Thoo Chai, my former supervisor, who inspired me to carry out research on long bean. I would like to gratefully acknowledge members of my supervisory committee, Dr. Azizah Osman and Dr. Ghizan Bin Saleh, for their generous assistance and encouragement in the preparation of this manuscript.

I am grateful to Bangladesh Agricultural Research Institute (BARI) for providing me deputation throughout my study period.

The financial support from CDP (Crop Diversification Programme), a CIDA (Canadian International Development Agency) funded project for the period of four years is gratefully acknowledged.

My sincere thanks are extended to Mr. Abdul Aziz Bashir (Former Senior Assistant Registrar of the Graduate School, UPM) for his assistance in different forms. My thanks and appreciation also go to Mr. Roslan Parjo, Laboratory Assistant for his help in NIRS analysis. Gratitudes are expressed



to the staff of Field 2, especially Mr. Shahril, for the technical assistance while conducting my field experiments.

Thanks are also due to fellow graduate students especially, Khandaker Abul Kalam Azad for his help in computer work, A.H.M. Razzaque, Syed Ahmed Khan, Morshed-e-Zahan, Kazi Nuruzzaman, and many others for their sincere cooperation in different ways.

To my parents, brothers and sisters, my father and mother- in - law for their continuous inspiration and prayers for the success of my study, I am deeply indebted.

My wife, Tahamina Mohaimen and my son, Zaheen Muhtasim Rahman Arthy deserve special recognition whose sacrifices, devotions, patience and understanding have always been a source of inspiration throughout the study period. I would like to thank my new born son, Zarif Mubassir Rahman Arko, who had spent many fatherless evening during this manuscript preparation. The help from my wife both in the field and lab work have made the completion of this degree possible.

Above all, I must say "THANKS GOD" who made it happen.



TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	iii
LIST OF TABLES.....	ix
LIST OF FIGURES.....	xvi
ABSTRACT.....	xix
ABSTRAK.....	xxiii
 CHAPTER	
I INTRODUCTION.....	1
II REVIEW OF LITERATURE.....	3
Botany of <i>Vigna sesquipedalis</i>	3
Origin and distribution.....	4
Cytogenetics and genetics.....	5
Genetics of shelf life.....	6
Inheritance of yield and other characters.....	7
Heritability.....	16
Heterosis.....	19
Inter-relationships among characters.....	24
Backcross breeding.....	29
Genetic basis of backcrossing.....	29
Population development by backcross breeding.....	31
III GENETICS AND HETEROSIS OF SHELF LIFE AND YIELD CHARACTERS IN LONG BEAN.....	36
Materials and methods.....	37



Parental materials.....	37
Hybridization and backcrossing.....	37
Agronomic practices.....	40
Pod collection.....	41
Collection of data.....	42
Data analyses	47
Scaling tests.....	47
Generation mean analysis.....	49
Estimation of heritability (narrow-sense).....	53
Estimation of heterosis.....	53
Results.....	54
Scaling test.....	54
Generation mean analysis.....	59
Gene effects in Cross 1 (L30 X KU7).....	59
Gene effects in Cross 2 (L30 X KU8).....	63
Gene effects in Cross 3 (KU7 X KU8).....	68
Gene effects in Cross 4 (L30 X CSL19).....	72
Heritability (narrow-sense).....	77
Heterosis.....	81
Cross 1 (L30 X KU7).....	81
Cross 2 (L30 X KU8).....	83
Cross 3 (KU7 X KU8).....	85
Cross 4 (L30 X CSL19).....	85
Performance of Cross 1 (L30 X KU7).....	89
Performance of Cross 2 (L30 X KU8).....	94
Performance of Cross 3 (KU7 X KU8).....	99
Performance of Cross 4 (L30 X CSL19).....	104



	Discussion.....	120
IV	INTER-RELATIONSHIPS AMONG CHARACTERS...	133
	Materials and methods.....	133
	Collection of data.....	134
	Statistical analyses.....	135
	Correlation coefficient.....	135
	Regression.....	135
	Results.....	137
	Correlation between characters.....	137
	Multiple regression analysis.....	144
	Multiple regression analyses between yield and other characters.....	144
	Multiple regression between shelf life and other characters.....	149
	Multiple regression with stepwise selection between pod yield per plant and other agronomic characters.....	149
	Multiple regression with stepwise selection between shelf life and other agronomic characters.....	159
	Discussion.....	164
V	IMPROVEMENT OF SHELF LIFE BY BACKCROSSING.....	167
	Materials and methods.....	168
	Data analyses.....	170
	Analysis of variance.....	170
	Selection and improvement.....	170
	Actual genetic gain.....	171
	Results.....	172
	Performance of Cross 1 (L30 X KU7).....	172



Performance of Cross 2 (L30 X KU8).....	175
Performance of Cross 4 (L30 X CSL19).....	179
Selection for shelf life in the backcross generations..	183
Variations and transgressive segregations in the backcross generations.....	193
Stepwise improvement through backcrossing.....	199
Actual genetic gain.....	206
Improvement of the characters under selection.....	209
Discussion.....	214
VI GENERAL DISCUSSION AND CONCLUSION.....	218
BIBLIOGRAPHY.....	229
VITA.....	242



LIST OF TABLES

Table		Page
1	Origin, shelf life, pod length and pod colour of four long bean cultivars/lines used as parents in the experiment	38
2	Marketability scores used for the measurement of shelf life in long bean.....	43
3	Expectation of means for parents, and descendent generations used in the generation mean analysis (Mather and Jinks, 1977).....	50
4	Scaling tests (A,B,C,D) for different characters in Cross 1 (L30 X KU7) of long bean.....	55
5	Scaling tests (A,B,C,D) for different characters in Cross 2 (L30 X KU8) of long bean.....	56
6	Scaling tests (A,B,C,D) for different characters in Cross 3 (KU7 X KU8) of long bean.....	57
7	Scaling tests (A,B,C,D) for different characters in Cross 4 (L30 X CSL19) of long bean.....	58
8	Estimates of gene effects for different characters in Cross 1 (L30 X KU7) of long bean.....	60
9	Estimates of gene effects for different characters in Cross 2 (L30 X KU8) of long bean.....	64
10	Estimates of gene effects from six parameter model for different characters in Cross 3 (KU7 X KU8) of long bean.....	69
11	Estimates of gene effects for different characters in Cross 4 (L30 X CSL19) of long bean.....	73
12	Heritability* (narrow-sense) for different characters measured in four crosses of long bean.....	78



13	Estimates of heterosis over mid-parent (MP) and better-parent (BP) values for shelf life and yield characters measured in Cross 1 (L30 X KU7) of long bean.....	82
14	Estimates of heterosis over mid-parent (MP) and better-parent (BP) values for shelf life and yield characters measured in Cross 2 (L30 X KU8) of long bean.....	84
15	Estimates of heterosis over mid-parent (MP) and better-parent (BP) values for shelf life and yield characters measured in Cross 3 (KU7 X KU8) of long bean.....	86
16	Estimates of heterosis over mid-parent (MP) and better-parent (BP) values for shelf life and yield characters measured in Cross 4 (L30 X CSL19) of long bean.....	87
17	Mean squares for shelf life and yield characters from the analysis of variance from population trials (P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 1 (L30 X KU7) of long bean.....	90
18	Mean, range and CV (percent) values for shelf life and yield characters (from P_1 , P_2 , F_1 , F_2 , BC_1P_1 , BC_1P_2 generations) in Cross 1 (L30 X KU7) of long bean.....	91
19	Mean values for the different characters measured in Cross 1 (L30 X KU7) of long bean....	93
20	Mean squares for shelf life and yield characters from the analysis of variance from population trial (P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 2 (L30 X KU8) of long bean.....	95
21	Mean, range and CV (percent) values for shelf life and yield characters (from P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 2 (L30 X KU8) of long bean.....	96
22	Mean values for the different characters measured in Cross 2 (L30 X KU8) of long bean....	98



23	Mean squares for shelf life and yield characters from the analysis of variance from population trial (P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 3 (KU7 X KU8) of long bean.....	100
24	Mean, range and CV (percent) values for shelf life and yield characters (from P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 3 (KU7 X KU8) of long bean.....	101
25	Mean values for the different characters measured in Cross 3 (KU7 X KU8) of long bean..	103
26	Mean squares for shelf life and yield characters from the analysis of variance from population trial (P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 4 (L30 X CSL19) of long bean.....	105
27	Mean, range and CV (percent) values shelf life and yield characters (from P_1 , P_2 , F_1 , F_2 , BC_1P_1 and BC_1P_2 generations) in Cross 4 (L30 X CSL19) of long bean.....	106
28	Mean values for the different characters measured in Cross 4 (L30 X CSL19) of long bean.....	108
29	Pearson correlation coefficients between yield components and other agronomic characters in Cross 1 (L30 X KU7) of long bean.....	138
30	Pearson correlation coefficients between yield components and other agronomic characters in Cross 2 (L30 X KU8) of long bean.....	139
31	Pearson correlation coefficients between yield components and other agronomic characters in Cross 3 (KU7 X KU8) of long bean.....	140
32	Pearson correlation coefficients between yield components and other agronomic characters in Cross 4 (L30 X CSL19) of long bean.....	141



33	Regression analysis between pod yield per plant (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 1 (L30 X KU7).....	145
34	Regression analysis between pod yield per plant (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 2 (L30 X KU8).....	146
35	Regression analysis between pod yield per plant (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 3 (KU7 X KU8).....	147
36	Regression analysis between pod yield per plant (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 4 (L30 X CSL19).....	148
37	Regression analysis between shelf life (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 1 (L30 X KU7).....	150
38	Regression analysis between shelf life (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 2 (L30 X KU8).....	151
39	Regression analysis between shelf life (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 3 (KU7 X KU8).....	152
40	Regression analysis between shelf life (dependent variable) and other agronomic characters (independent variables) of long bean in Cross 4 (L30 X CSL19).....	153
41	Regression analysis with stepwise selection at 0.15 entry level between pod yield per plant and other characters in Cross 1 (L30 X KU7) of long bean.....	155



42	Regression analysis with stepwise selection at 0.15 entry level between pod yield per plant and other characters in Cross 2 (L30 X KU8) of long bean.....	156
43	Regression analysis with stepwise selection at 0.15 entry level between pod yield per plant and other characters in Cross 3 (KU7 X KU8) of long bean.....	157
44	Regression analysis with stepwise selection at 0.15 entry level between pod yield per plant and other characters in Cross 4 (L30 X CSL19) of long bean.....	158
45	Regression analysis with stepwise selection at 0.15 entry level between shelf life and other characters in Cross 1 (L30 X KU7) of long bean.....	160
46	Regression analysis with stepwise selection at 0.15 entry level between shelf life and other characters in Cross 2 (L30 X KU8) of long bean.....	161
47	Regression analysis with stepwise selection at 0.15 entry level between shelf life and other characters in Cross 3 (KU7 X KU8) of long bean.....	162
48	Regression analysis with stepwise selection at 0.15 entry level between shelf life and other characters in Cross 4 (L30 X CSL19) of long bean.....	163
49	Mean squares from the analysis of variance on populations P_1 , P_2 , BC_1F_1 , BC_1F_2 , BC_1F_3 (selected) and BC_2F_1 for shelf life and yield characters measured in Cross 1 (L30 X KU7) of long bean.....	173



50	Mean, range and CV (percent) of shelf life and yield characters for different backcross generations in Cross 1 (L30 X KU7) of long bean.....	174
51	Mean squares from the analysis of variance on populations P_1 , P_2 , BC_1F_1 , BC_1F_2 , BC_1F_3 (selected) and BC_2F_1 for shelf life and yield characters in Cross 2 (L30 X KU8) of long bean.....	176
52	Mean, range and CV (percent) of shelf life and yield characters for different backcross generations in Cross 2 (L30 X KU8) of long bean.....	177
53	Mean squares from the analysis of variance on populations P_1 , P_2 , BC_1F_1 , BC_1F_2 , BC_1F_3 (selected) and BC_2F_1 for shelf life and yield characters in Cross 4 (L30 X CSL19) of long bean.....	180
54	Mean, range and CV (percent) of shelf life and yield characters for different backcross generations in Cross 4 (L30 X CSL19) of long bean.....	181
55	Variation and transgressive segregation in the backcross generations for five characters measured in Cross 1 (L30 X KU7) of long bean.....	194
56	Variation and transgressive segregation in the backcross generations for five characters measured in Cross 2 (L30 X KU8) of long bean.....	196
57	Variation and transgressive segregation in the backcross generations for five characters measured in Cross 4 (L30 X CSL19) of long bean.....	197



58	Percent individual plants selected for shelf life; shelf life and pod length; and shelf life, pod length and yield/plant from BC ₁ F ₂ and BC ₂ F ₁ generations of long bean. Selection was done on those with mean values equal or above the mean of the better parent.....	207
59	Actual genetic gain for shelf life in three crosses from BC ₁ F ₂ and BC ₂ F ₁ (backcross) generations of long bean.....	208
60	Percentage of improvement for yield characters in BC ₁ F ₂ and BC ₂ F ₁ generations after selection for long shelf life compared to the donor parent in Cross 1 (L30 X KU7) of long bean.....	210
61	Percentage of improvement for yield characters in BC ₁ F ₂ and BC ₂ F ₁ generations after selection for long shelf life compared to the donor parent in Cross 2 (L30 X KU8) of long bean.....	211
62	Percentage of improvement for yield characters in BC ₁ F ₂ and BC ₂ F ₁ generations after selection for long shelf life compared to the donor parent in Cross 4 (L30 X CSL19) of long bean.....	212



LIST OF FIGURES

Figure		Page
1	Mean shelf life of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean	111
2	Mean pod yield per plant of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	112
3	Mean pods per plant of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	113
4	Mean pod weight of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	114
5	Mean pod length of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	115
6	Mean seed weight of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	116
7	Mean days to harvest of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	117
8	Mean pod protein of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	118
9	Mean seed protein of parents, F_1 , F_2 and backcross generations ($BC_1P_1 = F_1XP_1$, $BC_1P_2 = F_1XP_2$) for four crosses of long bean.....	119



10	Frequency distribution of shelf life score of 200 BC ₁ F ₂ plants in Crosses 1, 2 and 4. The single arrow represents the mean shelf life of the male (donor) parent and the double arrow represents mean shelf life of the female (recurrent) parent.....	184
11	Regression of shelf life on pod yield per plant in successive backcross generations of Cross 1 (L30 X KU7) of long bean.....	185
12	Regression of shelf life on pod length in successive backcross generations of Cross 1 (L30 X KU7) of long bean.....	187
13	Regression of shelf life on pod yield per plant in successive backcross generations of Cross 2 (L30 X KU8) of long bean.....	188
14	Regression of shelf life on pod length in successive backcross generations of Cross 2 (L30 X KU8) of long bean.....	189
15	Regression of shelf life on pod yield per plant in successive backcross generations of Cross 4 (L30 X CSL19) of long bean.....	191
16	Regression of shelf life on pod length in successive backcross generations of Cross 4 (L30 X CSL19) of long bean.....	192
17	Mean shelf life of the backcross generations of long bean.....	200
18	Mean pod length of the backcross generations of long bean.....	201
19	Mean pod yield per plant of the backcross generations of long bean.....	202



20	Mean pods per plant of the backcross generations of long bean.....	204
21	Mean pod weight of the backcross generations of long bean.....	205



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)

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September, 1997

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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). F₁, F₂ 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 BC₂F₁ 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)

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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 F₁, F₂ 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 pemerinkatan 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 (I) 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 (I), 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