



UNIVERSITI PUTRA MALAYSIA

**VARIABILITY, DIVERGENCE, HETEROSIS, COMBINING ABILITY
AND YIELD COMPONENT STUDIES IN SWEET POTATOES
(IPOMOEA BATATAS (L) LAM.) FROM SABAH
AND SARAWAK, MALAYSIA**

MOHD SAID BIN SAAD

FP 1993 4



VARIABILITY, DIVERGENCE, HETEROSIS, COMBINING ABILITY
AND YIELD COMPONENT STUDIES IN SWEET POTATOES
(*Ipomoea batatas* (L) Lam.) FROM SABAH
AND SARAWAK, MALAYSIA

By

MOHD SAID BIN SAAD

Dissertation Submitted in Fulfillment of the Requirements for
the Degree of Doctor of Philosophy in the Faculty of
Agriculture, Universiti Pertanian Malaysia

September, 1993



ACKNOWLEDGEMENTS

I would like to express my grateful appreciation to my supervisor, Dr. Yap Thoo Chai, professor of plant breeding at the Department of Agronomy and Horticulture, Faculty of Agriculture, Universiti Pertanian Malaysia for his valuable guidance and supports throughout the research and preparation of the thesis. His continuous encouragement has helped me to develop my interest in the field of plant breeding.

I would like to gratefully acknowledge my co-supervisor, Dr. Mohd Nasir Azuddin, lecturer at the Department of Food Science, Faculty of Food Science and Biotechnology, Universiti Pertanian Malaysia for his encouragement during the preparation of the thesis.

Special thanks are due to my wife, Halimah Alma Othman for her continuous encouragement and typing the thesis.

The financial supports in the form of scholarship from SEARCA (Southeast Asian Regional Centre for Graduate Study and Research in Agriculture) and the research grant IRPA 1-07-05-17 provided by the Malaysian Government are gratefully acknowledged.



TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	iii
LIST OF TABLES.....	ix
LIST OF FIGURES.....	xiv
ABSTRACT.....	xvi
ABSTRAK.....	xix
 CHAPTER	
1. INTRODUCTION.....	1
2. LITERATURE REVIEW.....	4
Status of Sweet Potatoes.....	4
Area, Production and Distribution.....	4
Utilization.....	6
Origin and Evolution.....	7
Centre of Origin.....	7
Progenitor of Sweet Potato.....	8
Genetics of Sweet Potato.....	10
Cytogenetics.....	10
Inheritance of Characters.....	11



Variability in Sweet Potatoes.....	14
Interspecific Variability.....	14
Intraspecific Variability.....	15
Sweet Potato Breeding.....	19
Goals of Sweet Potato Breeding.....	19
Yield Components and Its Relationship with Other Characters.....	20
Inbreeding Depression and Hybrid Vigour.....	21
Mutation Breeding.....	22
Mass Selection and Polycross.....	23
Hybridization Breeding.....	25
Interspecific Hybridization.....	26
3. STUDIES ON THE VARIATION.....	28
Materials and Methods.....	28
Germplasm Collection.....	28
Germplasm Maintenance.....	31
Characterization and Evaluation.....	32
Polycross.....	36
Statistical Analyses.....	37
Results.....	39



	Phenotypic Variability within Accessions.....	39
	Variability within Polycross Progenies.....	56
	Discussion.....	63
4.	GENETIC DIVERGENCE AND HETEROSIS.....	71
	Materials and Methods.....	72
	Plant Materials.....	72
	Crossing.....	77
	Seed Germination and Preparation of Planting Materials.....	78
	Field Evaluation.....	78
	Collection and Analyses of Data.....	79
	Results.....	80
	Divergence between Genotypes.....	80
	Relationship between Distance Measurement.....	80
	Performance of Hybrid Progenies.....	82
	Relationship between F_1 Performance and Heterosis with Divergence Measurements.....	82
	Discussion.....	93
5.	COMBINING ABILITY STUDIES.....	96
	Materials and Methods.....	97



	Materials.....	97
	Field Trial and Experimental Design.....	97
	Collection of Data.....	98
	Analyses of Data.....	98
	Results.....	103
	Combining Ability.....	103
	Heritability.....	125
	Discussion.....	127
6.	CORRELATION ANALYSES AND YIELD COMPONENT STUDIES.....	131
	Materials and Methods.....	132
	Materials.....	132
	Field Planting.....	132
	Collection of Data.....	133
	Statistical Analyses.....	133
	Results.....	136
	Correlation between Characters.....	136
	Path Coefficient Analyses.....	138
	Multiple Regression between Yield and Other Agronomic Characters.....	140
	Discussion.....	143



7. GENERAL DISCUSSION AND CONCLUSION.....	146
BIBLIOGRAPHY.....	153
VITA.....	165



LIST OF TABLES

Table	Page
1. Number of Accessions and Location Details of Sweet Potato Germplasm Collected from the States of Sabah and Sarawak, Malaysia.....	30
2. List of the 16 Characters and the Methods to Measure Them for the Sweet Potatoes Collected for the Study.....	34
3. Means, Ranges and Coefficients of Variation for 12 Characters Evaluated in 99 Sweet Potato Germplasm Accessions Collected from Sabah and Sarawak, Malaysia.....	40
4. Means and Coefficients of Variation (CV) for 12 Characters of Sweet Potato from Five Regions in Sabah and Sarawak, Malaysia.....	45
5. Mean Squares Effects of Regions on the States of 12 Characters of Sweet Potatoes from Sabah and Sarawak.....	47
6. Means and Ranges of 12 Characters of the Three Sweet Potato Groups Formed by Ward's Cluster Analysis on the 99 Sweet Potato Accessions from Sabah and Sarawak.....	49
7. Univariate Test Statistics for Comparison Among the Three Sweet Potato Groups Revealed by Ward's Cluster Analysis for 11 Quantitative Characters.....	51
8. Character Loading on the First Two Axes Following Canonical Discriminant Analysis on Groups 1-3 Formed by Ward's Cluster Analysis on the 99 Sweet Potato Accessions from Sabah and Sarawak.....	53
9. Squared Canonical Correlation, Eigenvalue and Percent of Total Variation Accounted for by the Two Canonical Axes from Canonical Discriminant Analysis on Group 1-3 formed by Ward's Cluster Analysis on 99 Sweet Potato Accessions.....	54



10.	Distribution of the Sweet Potato Groups, Formed by Ward's Cluster Analysis, According to the Region.....	55
11.	Means, Ranges and Coefficients of Variation (CV) for Ten Characters of the 220 Polycross Progenies.....	57
12.	Means for 10 Characters of the Seven Sweet Potato Groups Formed by Ward's Cluster Analysis on the 220 Polycross Progenies.....	62
13.	Character Loading on the First Two Canonical Axes Following Canonical Discriminant Analysis on Groups 1-7 Formed by Ward's Cluster Analysis on the 220 Polycross Progenies.....	65
14.	Squared Canonical Correlations, Eigenvalues and Percent of Total Variation Accounted for by the First Three Canonical Axes Following Canonical Discriminant Analysis on Groups 1-7 Formed by Ward's Cluster Analysis on the 220 Polycross Progenies.....	66
15.	Source Location of the Six Sweet Potato Cultivars Used in the Heterosis Study.....	73
16.	Yield and Other Characteristics of the Six Sweet Potato Cultivars.....	75
17.	D ² -Values, Physical Distance (km), and Differences in Longitude (LG) and Latitude (LT) Among the Six Sweet Potato Cultivars.....	76
18.	Correlation Coefficients Between the Differences Between the Two Parents in D ² -Values, Physical Distance (km), Differences in Longitude (LG), Latitude (LT), and Differences in Nine Quantitative Characters in Sweet Potatoes.....	81
19.	Mean Values for Yield, Tuber Number, Mean Tuber Weight and Six Morphological Characters of 15 Sweet Potato Hybrid (F ₁) Progenies from Crosses between Parents with Different Divergence (D ²) Levels.....	83



20.	Correlation Coefficients Between D^2 -Values, Differences of Two Parents in Physical Distance (km), Longitude (LT), Latitude (LT), Yield, Tuber Number and Mean Tuber Weight with F_1 , Heterosis Over Mid-Parent (MP) and Heterosis over Better Parent (HP) for the Three Characters Studies.....	84
21.	Correlation Coefficients Between D^2 -Values, Differences of Two Parents in Physical Distance (km), Longitude (LT), Latitude (LT), Growth Rate, Internode Length and Vine Thickness with F_1 , Heterosis over Mid-Parent (MP) and Heterosis over Better Parent (HP) for the Three Characters Studied.....	86
22.	Correlation Coefficients Between D^2 -Values, Differences of Two Parents in Physical Distance (km), Longitude (LT), Latitude (LT), Leaf Size, Petiole Length and Petiole Thickness with F_1 , Heterosis over Mid-Parent (MP) and Heterosis over Better Parent (HP) for the Three Characters Studied.....	87
23.	D^2 -Values, Physical Distances (km) and Percentages of Heterosis over Mid-Parent for Yield, Tuber Number and Mean Tuber Weight for 15 Sweet Potato Crosses.....	89
24.	D^2 -Values, Physical Distances (km) and Percentages of Heterosis Over Mid-Parent for Six Morphological Characters for 15 Sweet Potato Crosses.....	91
25.	Analysis of Variance and Expectation of Mean Squares for the Diallel Cross Experiment with One Set of F_1 and Tested over y Years.....	99
26.	Analysis of Variance and Expectation of Mean Squares for the Diallel Cross Experiment with One Set of F_1	101
27.	Mean Squares from the Analysis of Variance on the 6×6 Diallel Cross for Yield, Tuber Number and Mean Tuber Weight.....	104
28.	Mean Squares for Combining Ability of the 6×6 Diallel Cross for Yield, Tuber Number and Mean Tuber Weight.....	105



29.	Estimates of Variance Components Due to General (σ_g^2) and Specific (σ_s^2) Combining Ability, Their Interaction with Year (σ_{gy}^2 , σ_{sy}^2) and Their Residual Error (σ_e^2), the Ratio of GCA to SCA (σ_g^2/σ_s^2) and Heritability (H).....	107
30.	Mean Squares of GCA, SCA and Error for Yield, Tuber Number and Mean Tuber Weight in Sweet Potatoes for the Trial Conducted in 1989 and 1990.....	108
31.	Estimates of Variance Components Due to General (σ_g^2) and Specific (σ_s^2) Combining Ability, the Residual Error (σ_e^2), the Ratio of GCA to SCA (σ_g^2/σ_s^2) and Heritability (H) for Yield, Tuber Number and Mean Tuber Weight of Sweet Potatoes.....	109
32.	Mean Values for Yield, Tuber Number and Mean Tuber Weight of 15 Hybrids from the 6 × 6 Diallel Cross of Sweet Potatoes Grown in 1989 and 1990.....	111
33.	Estimates of General Combining Ability Effects for Yield, Tuber Number and Mean Tuber Weight of Six Sweet Potato Cultivars Grown in 1989 and 1990	113
34.	Estimates of Specific Combining Ability Effects for Yield, Tuber Number and Mean Tuber Weight of 15 Hybrids from the 6 × 6 Diallel Cross of Sweet Potatoes Grown in 1989 and 1990.....	114
35.	Mean Squares from Analysis of Variance on the 6 × 6 Diallel Cross for Eight Morphological Characters of Sweet Potatoes...	116
36.	Mean Squares of GCA, SCA and Error for Eight Morphological Characters of the 6 × 6 Diallel Cross of Sweet Potatoes.....	117
37.	Estimates of Variance Components Due to General (σ_g^2) and Specific (σ_s^2) Combining Ability, the Residual Error (σ_e^2), the Ratio of GCA to SCA (σ_g^2/σ_s^2) and Heritability (H) for Eight Morphological Characters of Sweet Potatoes.....	118
38.	Mean Values for Eight Morphological Characters of 15 Hybrids from the 6 x 6 Diallel Cross of Sweet Potatoes.....	120
39.	Estimates of General Combining Ability Effects for Eight Morphological Characters of Six Sweet Potato Cultivars.....	121



40.	Estimates of Specific Combining Ability Effects for Eight Morphological Characters of 15 Hybrids from the 6 × 6 Diallel Cross of Sweet potatoes.....	122
41.	Estimates of Heritability (%) for Yield and Agronomic Characters of Sweet Potatoes.....	126
42.	Correlation Coefficients between Yield Components and Other Agronomic Characters in Sweet Potatoes.....	137
43.	Path Coefficient Analysis Showing the Direct and Indirect Effects of Yield Components and Other Agronomic Characters Toward Yield of Sweet Potatoes.....	139
44.	Regression Analysis between Yield (Dependent Variable) and Other Yield and Agronomic Characters (Independent Variables) of Sweet Potatoes.....	141
45.	Regression Analysis with Stepwise Selection at 0.15 Significant Level between Yield and Tuber Number, Mean Tuber Weight and Leaf Lobing in Sweet Potatoes.....	142



LIST OF FIGURES

Figure		Page
1.	Map of Sabah and Sarawak, Malaysia, Showing the Sites of Sweet Potato Germplasm Collection.....	29
2.	Frequency Distribution of Plant Type, Growth Rate, Internode Length and Vine Thickness of the 99 Sweet Potato Accessions from Sabah and Sarawak.....	42
3.	Frequency Distribution of Leaf lobing, Leaf Size, Petiole Length, Mature Leaf Colour and Immature Leaf Colour of the 99 Sweet Potato Accessions from Sabah and Sarawak.....	43
4.	Frequency Distribution of Yield, Tuber Number, Mean Tuber Weight, Tuber Dry weight, Tuber Skin Colour, Tuber Flesh Colour and Protein Content of the 99 Sweet Potato Accessions from Sabah and Sarawak.....	44
5.	Phenogram Resulting From Ward's Cluster Analyses on the 99 Sweet Potato Accessions from Sabah and Sarawak. At 0.11 Semi-Partial R^2 the Sweet Potato Accessions Could Divided into Three Groups.....	48
6.	Plot of Canonical Axes 1 (CAN 1) and 2 (CAN 2) Showing the Membership of the Grouping Obtained from Ward's Cluster Analyses on the 99 Sweet Potato Accessions from Sabah and Sarawak.....	52
7.	Frequency Distribution of Plant Type, Growth Rate, Internode Length and Vine Thickness of the 220 Polycross Progenies.....	58
8.	Frequency Distribution of Leaf lobing, Leaf Size, Petiole Length, Mature Leaf Colour and Immature Leaf Colour of the 220 Polycross Progenies.....	59



9.	Frequency Distribution of Yield and Tuber Number of the 220 Polycross Progenies.....	60
10.	Plot of Canonical Axis 1 (CAN 1) and 2 (CAN 2) Showing the Membership of the Grouping Obtained from Ward's Cluster Analyses on the 220 Polycross Progenies.....	64
11.	Maps of Sabah and Sarawak, Malaysia, Showing the Sites of Source Location of the Six Sweet Potato Cultivars Used in the Heterosis Study.....	74



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

**VARIABILITY, DIVERGENCE, HETEROSIS, COMBINING ABILITY AND
YIELD COMPONENT STUDIES IN SWEET POTATOES
(*Ipomoea batatas* (L) Lam) FROM SABAH
AND SARAWAK, MALAYSIA**

By

MOHD SAID BIN SAAD

September 1993

Supervisor: Professor Yap Thoo Chai

Faculty: Agriculture

Studies were conducted to examine the breeding potential of the Malaysian indigenous sweet potato germplasm. A total of 99 sweet potato accessions was collected from five different regions in the states of Sabah and Sarawak, Malaysia. A total of 220 polycross progenies was obtained from sixteen randomly chosen accessions planted in a polycross block. The 99 accessions and their 220 progenies were evaluated in the field and 16 characters were measured. With the exception of plant type and vine thickness, other characters showed more than 20% CV values. The CV values for yield, tuber number and mean tuber weight were 76%, 57% and 48%, respectively. The means and CV's were similar for all characters between the regions indicating the presence of similar sweet potato type in all the regions. Cluster analysis showed the presence of three main groups of sweet potatoes in the states. Group 1 comprised cultivars with low yield.



Cultivars in Group 2 were high yielding with spreading plant type. The third group comprised only six cultivars with orange flesh colour, big leaves, semi-compact plant type and slightly lower yield. The mean, range and CV values for all characters studied were much larger for the polycross progenies as compared to the parents. Cluster analysis showed the presence of seven groups among the progenies indicating the formation of new genotypes as a result of outcrossing. Gene interactions in the new genotypes probably have led to the presence of larger means and ranges of many characters.

Analysis on diallel cross among six sweet potato accessions with different D^2 -value showed the presence of more than 40% heterosis from many cross combinations for yield characters. With a few exceptions, most crosses showed less than 20% heterosis for morphological characters. The heterosis expressions for both yield and morphological characters showed no clear relation with D^2 -values (divergence), differences between parental values, physical distance (km), longitude and latitude. The results indicated that heterosis expression did not depend on overall genetic divergence and different genes probably had different divergence levels depending on their response to eco-geographical variables.

The results of combining ability analyses showed significant GCA and SCA for yield, tuber number and mean tuber weight indicating the importance of both additive and non-additive gene actions for these characters. However, the GCA variances for yield and mean tuber weight



were much larger than their respective SCA variances, whereas the SCA variance for tuber number was six times larger than its GCA variance. Plant type, growth rate, internode length, vine thickness, leaf lobbing and petiole thickness showed significant difference only for SCA but not GCA. Significant difference for GCA was found for leaf size only but not for both GCA and SCA for petiole length. The results revealed that GCA was more prevalent in yield, mean tuber weight and leaf size. SCA was more important for tuber number, plant type, growth rate, internode length and leaf lobbing.

Correlation studies failed to relate yield with other agronomic characters. Regression analysis showed that leaf lobbing was the third important yield contributing character besides tuber number and mean tuber weight. Number of tubers per plant and mean tuber weight were the two main components of yield. Yield in sweet potatoes was determined by the following formula, $\text{Yield} = -0.387 + 2.684 \text{ mean tuber weight} + 0.159 \text{ tuber number} - 0.032 \text{ leaf lobbing}$.

The findings showed that a substantial amount of genetic variability and genetic divergence occurred in the local sweet potatoes. Exploitation of heterosis through biparental crossing between selected parents is a good approach for breeding this crop. Selection of parents, however, should not base solely on the divergence of the two parents but their combining ability should also be considered.



Abstrak disertasi yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Filasafah.

**KAJIAN KEPELBAGAIAN, PERCAPAHAN, HETEROSIS, KEUPAYAAN
BERGABUNG DAN KOMPONEN HASIL TANAMAN KELEDEK
(*Ipomoea batatas* (L) Lam) DARI SABAH
DAN SARAWAK, MALAYSIA**

Oleh

MOHD SAID BIN SAAD

September 1993

Penyelia: Profesor Yap Thoo Chai

Fakulti: Pertanian

Kajian telah dilakukan untuk menentukan potensi germplasma tanaman keledek tempatan Malaysia. Sebanyak 99 aksesori telah diperolehi dari lima wilayah di negeri Sabah dan Sarawak, Malaysia. Seterusnya, 220 progeneri polikacukan didapati dari 16 aksesori yang diperolehi secara rawak dari himpunan germplasma tersebut yang ditanam dalam blok polikacukan. Semua 99 aksesori dan 220 progeneri polikacukan tersebut telah diuji di ladang dan data diperolehi dari 16 sifat. Semua sifat yang dikaji, kecuali bentuk pokok dan tebal batang, menunjukkan nilai CV yang melebihi 20%. Sifat hasil mempunyai nilai CV yang tinggi iaitu 76% untuk hasil, 57% untuk bilangan ubi dan 48% untuk purata berat ubi. Nilai purata dan CV untuk semua sifat yang dikaji adalah hampir sama bagi kelima-lima wilayah tersebut. Ini menunjukkan bahawa tiap wilayah mempunyai jenis keledek yang serupa. Analisis kelompok membahagikan germplasma keledek tersebut kepada tiga kumpulan. Kumpulan 1 terdiri dari varieti yang berhasil

rendah. Varieti dari Kumpulan 2 berhasil tinggi dan mempunyai bentuk pokok yang merayap. Kumpulan 3 terdiri dari hanya enam varieti yang semuanya mempunyai ubi bewarna oren, saiz daun yang lebar, bentuk pokok merumpun dan mempunyai hasil yang rendah. Nilai purata, julat dan CV sifat-sifat yang dikaji adalah lebih tinggi di kalangan progeni polikacukan berbanding induknya. Analisis kelompok membahagikan progeni tersebut kepada tujuh kumpulan. Ini menunjukkan genotip baru terbentuk hasil dari kacukan. Saling tindakan gen dalam genotip baru tersebut mungkin menyebabkan wujudnya nilai purata dan julat yang lebih besar untuk kebanyakan sifat dikalangan progeni tersebut.

Keputusan analisis kacukan dwialel menggunakan enam aksesori keledak dengan nilai D^2 yang berlainan, menunjukkan heterosis sifat hasil yang melebihi 40%. Untuk sifat morfologi, kecuali beberapa kombinasi kacukan, kebanyakan kacukan memberikan nilai heterosis yang kurang dari 20%. Heterosis untuk sifat hasil dan morfologi tersebut tidak mempunyai hubungan nyata dengan nilai D^2 (percapahan), perbezaan nilai induk, perbezaan jarak fizikal (km), longitud dan latitud. Ini menunjukkan heterosis tidak bergantung sepenuhnya kepada percapahan menyeluruh genetik induk dan gen mengalami kadar percapahan yang berbeza bergantung kepada tindak-balasnya terhadap pembolehubah eko-geografi.

Analisis keupayaan bergabung memberikan nilai GCA dan SCA yang bermakna untuk sifat hasil, bilang ubi dan purata berat ubi. Ini menunjukkan kedua-dua tindakan gen menambah dan gen tak-menambah memainkan

peranan dalam menentukan hasil keledak. Walau bagaimanapun, nilai varians GCA hasil dan purata berat ubi adalah lebih besar berbanding nilai varians SCA nya, sebaliknya nilai varians SCA untuk bilangan ubi pula adalah lebih besar dari varians SCA. Untuk bentuk pokok, kadar pertumbuhan, panjang ruas, tebal batang, bentuk cuping daun dan tebal tangkai daun hanya SCA yang bermakna. Nilai GCA yang bermakna hanya dari luas daun. Kedua-dua GCA dan SCA untuk panjang tangkai daun tidak bermakna. Keputusan ini menunjukkan bahawa GCA penting untuk sifat hasil, purata berat ubi dan luas daun, manakala SCA lebih penting untuk bilangan ubi, bentuk pokok, kadar pertumbuhan, panjang ruas and bentuk cuping daun.

Kajian korelasi gagal menunjukkan perhubungan antara sifat hasil dengan sifat agronomi yang lain. Analisis regresi mendapati bahawa bentuk cuping daun adalah sifat penyumbang hasil yang ketiga penting disamping bilangan dan purata berat ubi yang merupakan dua sifat penyumbang hasil yang utama. Hasil keledak ditentukan oleh formula berikut, hasil = - 0.387 + 2.684 berat ubi + 0.159 bilangan ubi - 0.032 bentuk cuping daun.

Keputusan kajian ini menunjukkan masih wujud kepelbagaian yang besar dikalangan keledak tempatan. Memperolehi heterosis melalui kacukan antara dua induk terpilih merupakan kaedah yang sesuai untuk membiakbaka tanaman ini. Walau bagaimanapun, memilih pokok induk harus berdasarkan tidak hanya pada kadar percapahan genetik tetapi juga kepada keupayaan bergabung antaranya.

CHAPTER 1

INTRODUCTION

The sweet potato, *Ipomoea batatas* (L.) Lam., is the second important tuberous food crop in the world after the Irish white potato, *Solanum tuberosum* (Horton, 1987). The crop is grown in more than 100 countries (Horton, 1989) with different climatic conditions located between 15°S and 45°N (MacKay, 1989). The sweet potato tuber is a staple food in Papua New Guinea, Irian Jaya (Indonesia), Vietnam and some parts of China (MacKay, 1989). In Taiwan, it is used as animal feed (Yeh, 1982). In Japan, 40% of sweet potato tubers are for table food and about 30% as the material for starch production (Kobayashi and Sakamota, 1988). In many developing countries the tips of the sweet potato vines are also consumed as vegetable (Villareal, 1982).

In Malaysia, sweet potato is normally grown in small scale, with the average farm size of less than 0.1 hectare (Saad and Yap, 1986). However, farms with more than 10 hectares in size are found in the states of Kedah, Johore, Kelantan and Pahang. In Kelantan, sweet potato is planted alternate



to tobacco and rice and in Kedah sweet potato is planted under young rubber trees as an intercrop. There are more than 7,000 hectares of sweet potato in Malaysia (Khelikuzzaman and Saad, 1987).

Research on sweet potato improvement is very limited in Malaysia. There is no established variety in the country. Most farmers grow their own cultivars (Saad and Yap, 1986). These cultivars are normally selected from several cultivars obtained from other farmers or their friends. Nevertheless, some advanced farmers have brought in superior varieties from other countries such as China and Indonesia. Sweet potato breeding in the past was only confined to screening of cultivars from the collections. From 1948 to 1969, a total of 44 varieties was evaluated by the Department of Agriculture. Four of them namely Large white, Serdang-1, Hoey Tong and Empat Bulan were recommended for planting. However, these varieties were not popular among the farmers. In the early 1980's, Malaysian Agricultural Research and Development Institute (MARDI) had collected more than 500 sweet potato accessions from Peninsular Malaysia (Khelikuzzaman, 1986). Evaluation on part of the germplasm resulted in one variety named Bukit Naga. However, later trials showed that this variety yielded 25% lower than the AVRDC variety, CN 941-32 (Khelikuzzaman and Saad, 1987).

Evidently, the full potential of the local sweet potato germplasm has to be fully exploited. Selecting the best local varieties is undoubtedly the most important step in a breeding programme. However, the potential of the germplasm cannot be fully exploited until hybridization is done. Hybridization allows formation of new segregating genotypes. Furthermore, if the right parents are used one might be able to exploit the heterosis and more vigorous hybrids can be produced through vegetative propagation. In Malaysia, some prominent varieties of other crops are derived from crosses between parents from locally adapted, indigenous cultivars or from overseas. However, in sweet potato, breeding by hybridization has yet to be started in Malaysia.

The objectives of the study were to determine the variability and divergence in relation to heterosis, inter-relationship among agronomic characters and at the same time also try to get information on combining ability of some genotypes of the characters studied in order to set up the sweet potato breeding programme in Malaysia.

CHAPTER 2

LITERATURE REVIEW

Status of Sweet Potatoes

Area, Production and Distribution

The sweet potato originated in the New World. However, the main growing areas are in Asia and Oceania. In 1987, there were 8.6 million hectares planted with sweet potatoes in the world producing about 116 million tons of tubers (Mackay, 1989). According to Horton (1988), about 80% of the sweet potato areas are in Asia, 15% in Africa and about 6% in the rest of the world. China, the main sweet potato producing country, produced 94 million tons of sweet potato tubers per year from 6.9 million hectares (Mackay, 1989), followed by Vietnam (500,000 hectares) (Mai, 1989), Indonesia (325,000 hectares), India (212,000 hectares), the Philippines (191,000 hectares) and Papua New Guinea (102,000 hectares) (Mackay, 1989). Japan has about 65,000 hectares of sweet potato with the annual production of 14 million tones. This is the only developed country which produces a substantial amount of sweet potato.