PROFILING THE DIVERSITY OF MORPHOLOGICAL TRAITS FOR FUTURE MALAYSIAN BREEDING PROGRAMME IN CAPSICUM GENETIC RESOURCES

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Especially dedicated to my understanding husband,

Mohammad Azhari bin Abdul Rahman and my toughest son, Ammar Yusuf.

Thank you to my beloved mother and father.

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ABSTRACT

Capsicum spp. is a very important crop in Malaysia because of high demand in local market. However, local chili production is low mainly due to poor seed quality or unavailability of high yielding varieties under tropical environment. Thus, the aim of the research project was to assess the morphological characteristics in 45 *Capsicum* genetic resources, collected from local and exotic resources. The *Capsicum* genotypes were characterized for speed of germination (SG), germination energy (GE), plant height (PH), leaf area (LA), days to flowering (DFL), days to fruiting (DFR), total fruit weight (TFW), fruit length (FL), fruit dry weight (FDW) and seed dry weight (SDW). The data of these traits were subjected to analysis of variance (ANOVA), correlation analysis and multivariate analysis using cluster analysis based on percent similarity coefficient. ANOVA revealed that local as well as exotic *Capsicum* genetic resources exhibited diversity for all the morphological parameters. TFW showed the maximum diversity as compared to other traits. However, the least diversity was shown in PH trait. TFW exhibited positive correlation with FDW, SDW, LA, DFR, DFR and FL for both exotic and local *Capsicum* spp. Thus, direct selection for traits; TFW, FDW, SDW, LA, DFL, DFR, and FL will be helpful for selection of chili varieties in Malaysia. Through cluster analysis, both genotypes of exotic and local *Capsicum* spp. had been clustered into two major cluster at 64.08% similarity coefficient, and also grouped into 12 sub-clusters at 78.88% similarity coefficient. Cluster I to cluster VIII was in major group 1 while cluster IX to XII in major group 2. For better emphasis, PA10, PA38 and L10 were the most unique compared to the rest because they were classified as a single genotype in a node with similarity coefficient at 76.34%. Genotype L10 was the most outstanding compared to the rest due to its uniformed flowering and fruiting. Therefore, the selection of high yielding variety within both major clusters can be an advantage for future breeding programme.

ABSTRAK

Capsicum spp. adalah merupakan tanaman yang penting di Malaysia kerana cili mempunyai permintaan yang tinggi di pasaran tempatan. Namun, bekalan cili di pasaran sangat rendah kerana dipengaruhi faktor biji benih yang kurang berkualiti dan berhasil tinggi di bawah persekitaran tropik. Oleh itu, tujuan utama penyelidikan ini adalah untuk menilai ciri morfologi pada 45 sumber genetik *Capsicum* spp. yang terdiri daripada sumber tempatan dan juga eksotik. Genotip cili ini akan dinilai berdasarkan ciri kecepatan percambahan (SG), tenaga percambahan (GE), tinggi pokok (PH), luas daun (LA), bilangan hari untuk berbunga (DFL), bilangan hari untuk berbuah (DFR), jumlah keseluruhan berat buah (TFW), panjang buah (FL), berat buah selepas kering (FDW) dan berat biji benih selepas kering (SDW). Data ciri-ciri morfologi ini akan dinilai melalui analisis varians (ANOVA), analisis korelasi dan analisis multivariat menggunakan analisis kelompok berdasarkan persamaan koefisien. Dalam kajian ini, ANOVA menunjukkan terdapat perbezaan yang signifikan kepada semua ciri morfologi yang direkod pada cili tempatan dan juga eksotik. Ini menunjukkan wujudnya ruang kepelbagaian yang besar antara genotip. TFW menunjukkan diversiti yang tertinggi berbanding ciri morfologi yang lain manakala PH merupakan ciri morfologi yang terendah. TFW menunjukkan positif korelasi pada FDW, SDW, LA, DFR, DFR dan FL pada kedua-dua jenis cili tempatan mahupun eksotik. Oleh itu, pemilihan genotip berdasarkan ciri-ciri tersebut dapat membantu menambahbaik kepelbagaian cili di Malaysia. Berdasarkan analisis kelompok, genotip *Capsicum* spp. yang terdiri daripada tempatan dan eksotik telah dikumpulkan kepada dua kelompok utama di persamaan koefisien 64.08%, dan juga dikumpulkan kepada 12 sub-kelompok di persamaan koefisien 78.88%. Sub-kelompok I hingga sub-kelompok VIII adalah tergolong dalam kelompok utama satu manakala sub-kelompok IX hingga sub-kelompok XII adalah dalam kelompok utama dua. Genotip PA10, PA38 dan L10 adalah yang paling unik kerana direkodkan sebagai genotip di nod individu dengan persamaan koefisien 76.34%. Genotip L10 yang paling menyerlah kerana faktor keseragaman tempoh untuk berbunga dan berbuah. Oleh itu, pemilihan genotip yang mempunyai ciri hasil yang tinggi di antara dua kelompok utama ini akan memberi kelebihan dalam program pembiakbakaan tanaman cili pada masa hadapan.

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LIST OF SYMBOLS

%	-	Percentage
cm	-	Centimetre
cm^2	-	Centimetre square
g	-	Gram
L	-	Length
W	-	Width
±	-	Plus minus
R^2	-	Coefficient of multiple determination

LIST OF ABBREVIATIONS

GE	-	Germination energy
SG	-	Speed of germination
PH	-	Plant height
LA	-	Leaf area
DFL	-	Days to flowering
DFR	-	Days to fruiting
FDW	-	Fruit dry weight
FL	-	Fruit length
TFW	-	Total fruit weight
SDW	-	Seed dry weight
UPGMA	-	Unweighted Pair Group Method using Arithmetic Average
ANOVA	-	Analysis of variance
SAS	-	Statistical Analysis Software
MVSP	-	Multivariate Statistical Program
IPGRI	-	International Plant Genetic Resources
AVRDC	-	Asian Vegetable Research and Development Centre
FAO	-	The Food and Agriculture Organization
CV	-	Coefficient variation
M	-	Mean
SD	-	Standard deviation

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CHAPTER 1

INTRODUCTION

1.1 Introduction of Research

Chili (*Capsicum* spp.), an annual or perennial herbs or shrubs, was originated from Andean region or so called South and Central America, then it was domesticated to Africa and Asia via Europe (Tsaballa *et al.*, 2015). *Capsicum* spp. has a true diploid chromosome 2n = 2x = 24 with a pubescence leaves and stem range from glabrous to very pubescent. Furthermore, chili has varied genetic diversity and great geographical distribution (Votava, Baral and Bosland, 2005). This species was also known as chili, chile, chilli, aji, and paprika (Yoon *et al.,* 1989). *Capsicum* species is belong to Solanaceae family; there are about 27 species, but the most known are five domesticated species and currently cultivated; *C. annuum, C. frutescens, C. pubescens, C. chinense, C. baccatum,* (Zewdie *et al.,* 2004; Moscone *et al.,* 2007). Chili is rich with proteins, lipids, carbohydrates, fibres, mineral salts, vitamins and phytochemical compounds, such as ascorbic acid, carotenoids, flavonoids and capsaicinoids (El-Ghorab *et al.*, 2013). These compounds have significant impact in preventing chronic diseases such as cancer, asthma, stimulation of the immune system, cataracts, anti-microbial, antioxidant and cardiovascular (Nascimento *et al.*, 2013).

Capsicum spp. is a necessary cash crop, which consumed as vegetable or food, and processed products (Votava *et al.,* 2005). Chili is important as one of the major ingredient in culinary preparations especially in Asia countries including Malaysia, India, and Bangladesh purposely for its pungency (Farhad *et al.,* 2008). While in the originated countries; Mexico, chili had been used as food and condiment, dry form and pickled. Chili such as Jalapeno was popular used to prepare sauces and guacamole; a smashed avocado (Orellana-Escobedo *et al.,* 2013). Cultural traits such as food and health benefit, is one of the main factor that influenced the preference patterns in different population groups and also synonym to the practices and local environmental specificities (Portis *et al.,* 2006). In consequence, the preferable chili can be evaluated through market recognition and the industry-scale in different regions and countries.

This perennial shrub is a very important crop in Malaysia, mainly *C. annuum* so called chili and *C. frutescens* so called eye-bird chili were usually grown, predominantly as a spice crop and for their both hot and sweet taste (Usman *et al.,* 2014; Bozokalfa *et al.,* 2009). Despite the great economic and cultural importance of chili in worldwide and Malaysia, however, local production of chili is not sufficient enough for market's demand due to the uncontrolled weather and rain season. According to FAOSTAT (2013), it is estimated that chili growers in Malaysia are producing 59,775 tonnes per year, which area harvested that been covered is 4,014 hectare in 2013. The concern of this shortage in the supply of chili is more chili was imported from neighbourhood countries such as China, India and Thailand to fulfil local needs.

There are vast varieties of each *Capsicum* species in different countries and origin. Thus, the plant germplasm is crucial for genetic diversity in collecting, maintaining and developing new cultivars with enhance traits such as high yield, adapted to the environment, or resistant to pest and pathogens which is required for both farmers and breeders. The potential of these genetic resources especially in tropical environment need to be explore as there was lack of information on seed potential emergence, growth trait and yield related components. A part of that, several

of the species in the genus; domesticated species and their wild relatives, can be grouped into species- complexes which allow for genetic exchange between the species (Ibiza *et al.*, 2012).Thus, the generated information will provide a guide line to select superior varieties as well as to breed high yielding varieties with improved productivity for tropical environmental conditions.

1.2 Problem Statement

In Malaysia, chili is a very important vegetable crop and grown all over districts with wide range of variability. However, local production of chili is not sufficient enough for local market due to the distribution of low-quality seed, high incidence of pest and disease attacks, climate change and inadequate marketing infrastructure. Furthermore, high demand on chili crop pushes the small farmers to grow the local chili in different environment and techniques. In consequences, chili has potential chances to be cross pollinated with other varieties and the genetic identity of the landraces can be diminished as majority of chili is open pollinated type. Chili farmers were also using the hybrid varieties in order to increased yield. The concern is not only the dependable of seeds annually, but the inbred lines will also be affected.

Meanwhile, genetic diversity of breeding lines had getting smaller and some useful genes in the landraces were lost due to the breeding activities. Thus, in order to evade genetic erosion is by collecting and maintaining the germplasm the variation of the germplasm worldwide for further used by researcher in future breeding programme. Besides that, the plant genetic resources are essential for genetic diversity to obtain new cultivars which may vary in form of their morphological traits including phenotypic characteristics such as shape, size and color of fruit, color and size of leaf and quantitative characteristics such as fruit length, fruit weight and number of fruits per plant (Rao and Hodgkin, 2002). In order to achieve this purpose, multivariate

methods have become an important tool in the valuation of maintained genotypes (Sudré *et al.*, 2010). Diversity of varieties in *Capsicum* spp. used in this study will assist on precise of genetic variability information for future use.

1.3 Research Objectives

The objectives of this research were:

1. To estimate morphological characteristics of exotic and local *Capsicum* spp. under tropical environment.
2. To evaluate correlation study among morphological characteristics of exotic and local *Capsicum* spp. under tropical environment.
3. To classify the exotic and local *Capsicum* spp. based on similarities and differences in morphological characteristics using cluster analysis.

1.4 Scope of the Study

In order to achieve the objectives, four scopes were outline in this research. First, collection of *Capsicum* spp. germplasm consisted of exotic and local varieties for the study. Then, planting and maintaining the *Capsicum* spp. varieties on site was also done to obtain the data of morphological characteristics. Evaluation of the morphological variability using analysis of variance method and correlation analysis among morphological traits for exotic and local *Capsicum* spp. under tropical environment. Classification of exotic and local *Capsicum* spp. into groups by using the clustering analysis through dendogram figure.

1.5 Significance of Research

The data information obtained from this study will help the researcher to classify the varieties within a cluster group based on the similarities and differences in morphological characteristics. Thus, through the result of clustering analysis and morphological variability, the variation within exotic and local *Capsicum* spp. can be observed. The presence of variability in exotic *Capsicum* spp. can be further used to enhance the local chili germplasm in future breeding programme. Crossing between varieties from different cluster group will result new population with higher variability which can be use by local farmers.

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