CHAPTER II

LITERATURE REVIEWS

2.1 Importance and cultivation of melons in Thailand

The scientific name of melon is *Cucumis melo* L., belonging to the family *Cucurbitaceae.* The number of chromosomes 2n=24. It's a cross pollinated crop by insects and wind but high self-pollination in cultivars with perfect flowers (Khanobdee, 1998). Melon was high-yielding economic crop and likely to increase of the market demand. However, the commercial was production of melon often has a problem with the accumulation of diseases and insects when the melon is continuously grown (Tira-umphon, 2000). Melon was popular fruit grown many more of Thailand's provinces, including Khon Kaen, Chiang Mai, Buriram, and others, with a tendency to expand further, because it was popular in the general market and supermarkets. Melon was eaten as a fresh fruit, due to the sweetness, aroma, and good taste. Farmers can grow melons for extra income, and good quality products will have a high price (Department of Agricultural Extension, 2016). In addition, melon was the fruit with highest beta-carotene content the human body needs and converts beta-carotene into vitamin A. Molon was rich in vitamin C that the human body needs for body functions. It was also protecting us from colds, cancer, and heart disease (Charlotte, 2007). In 2021, Thailand had 480.78 kilogram of melon seed imports, more than 4 million baht (The Office of Agricultural Regulation, 2021). Many seeds were imported because nowadays most Thai farmers prefer to grow melons commercially with hybrid seeds, because of high productivity. There were some characteristics that stand out and was consistent in various ways.

Galia melon (Cucumis melo L. var. reticulatus Ser.) was one popular variety of grow. It has the following characteristics: an average weight of 1 kilogram, a rounded shape, a thick net, a rough surface and when fully grown will turn yellow, sweet taste and a great aroma (Mitchell, 2007). Galia melon was a type of F_1 hybrid melon breeding

from a cross between the green-flesh melon cultivar 'Ha-Ogen' and the netted-rind melon cultivar 'Krimka', which developed by the melon breeder Dr. Zvi Karchi and released in 1973 (Karchi, 2000).melon

2.2 The botanical characteristics of melon

Melon was a vine climbing through a branch. The trunk was round with thorns resembling a hairy, clinging to a single leaf, alternately petioles hollow. The base of the concave leaf base. The jagged edges were wavy, the surface was rough, young leaves had hair at the edge of the leaf and under the leaves. There were both staminate flowers, pistillate flowers and complete flowers on the same plant. All cultivars had color, peel and pulp color vary according to varieties. The pulp may be yellow, yellowish green color and orange color. The seeds were brownish yellow color (Pooma, 2014). Galia melon had scientific name *Cucumis melo* L. var. *reticulatus* Ser. Also known as musk melon, netted melon, or nutmeg melon. The skin was straw-colored with a tightly woven mesh pattern. The fruit was medium in size, fragrant, fine melon, orange, sweet (Chimongkon, 1985).

2.3 The environment that is suitable for melon growth

Melon grows well at temperatures between 25-35 °C. The suitable season was the end of the rainy season or the beginning of winter. If planting melons were cold climates, such as night when the lower temperature, it will halt the growth from the seedling stage effect the growth and harvesting slow down. However, if the weather gets cold suddenly, the melon will have only staminal flowers, and will not have hermaphrodite or festinate flowers, Hermaphrodite flowers or festinate flowers will appear when the weather was warmer, or these flowers may be found on the higher segments of the plant. If planted in hot weather, it will often be found that the festinate flowers are not growing, or are having problems with breeding, the flowers will be yellow and fall. An environment in which the plant receives insufficient sunlight limiting the production of plant food. Relative humidity was also important for plant growth, low relative humidity in the air, causes high dehydration of the plants, as a result, the

plants can absorb more nutrients through their roots, which is also suitable for, pollination, fruiting, and growth (Tira-umphon, 2016).

2.4 Cross breeding plant improvement and Inbred line extraction

Plant breeders must plan research with the objectives of breeding because it will make the breeding of plants successful. Then study the relevant information such as the nature of the plant to be breed, propagation mating, characteristics genetic diversity and relevant genetic information such as qualitative or quantitative characteristics, heterosis and heritability. This information will be helpful in making informed plant breeding decisions and effective to achieve the objectives (Kankaew, 2011). The breeding for cross-pollination crop, found that each plant has heterozygous of characteristics. When many plants were combined in cross-plant populations, this causes the population to be given a qualification as a heterogeneous population because of hybrid lines had good characteristics. This was because their genes had the over dominant characteristics or epistasis. At the same time as having genetic diversity, allowing the plants to be able to adapt to the changing environment. In cross-pollination crop, the resulting hybrid had different from the parental, which is the first selection in the hybrid, believing that it will achieve good characteristics because it was a self-pollination crop, so in the later stages of cross breeding the plant will become homozygous (Chaitiang, n.d.). The production of inbred line that every plant has the same genotype. In the self-pollination crop, which had homozygous genotype and the same, every seed. Therefore, it was automatically inbred line, but in cross-pollination crop such as melon was each plant of each seed was heterozygous when constantly self-pollinated weakens the plant. The inbred line selection method, adapted from Johannsen method, used to selected *Phaseolus vulgaris*, selecting from many plants, and then plant-to-row or head-to-row, the key was that the selected plants must had different genotypes, and genotype was homozygous. The inbred line selection can be done in several ways, for example inbred selection. In cross-pollination crop were produced by self-pollination. Then selected was to produce hybrids next (Laosuwan, 2003). When inbred lines were obtained and then tested for the combining ability of the inbred lines by diallel cross method to find a suitable breed for use as a parent in

further breeding program, then to produce F_1 hybrid seeds. (The Office of Agricultural Research and Extension Maejo University, 2016).

Khanobdee (2014) Inbred line selection of cucumber gherkin varieties for mildew resistance using 3 methods such as inbred line selection, pedigree selection, and back cross selection, found that the average genetic regression of mildew levels equal to 29.4% -26.4% and -1.5%.

Pidkwamlub (2014) Inbred line selection in the hybrid glutinous rice corn improvement project and genetic testing, which selecting population by S1 selection: (1) half - sib (HS), (2) full - sib (FS), and (3) S1- progeny test (S1); this method was able to select S2 population with good agricultural potential.

2.5 Gene action

The characteristics of living organisms can be divided into 2 basic genetics.

1. Qualitative characteristics are characterized and controlled by a little pair of genes, each pair expresses clearly, distribution of genes in various generations, clearly organized into groups, which the environment rarely influences such as appearance of pulp color, peel color, and disease resistance etc.

2. Quantitative characteristics are characterized and controlled by many genes, each of the genes showed the genotype were non-clearly, the distribution of genes in various generations cannot be clearly classified, the environment has a lot of influence on expression such as weight, sweetness, and pulp thickness of fruit, etc. (Boonhong, 2005: References in Kachen, 2008). The gene action can be divided into 2 groups as follows: **1) The synergies of genes in different positions** are the sum of the results, instead of the sum of the same genes, the sum of the different genes that control the same nature. Many genes that control the same nature in a positive way are called multiple factors, which each gene works independently. **2) The synergies of the genes within the same locus include.**

Additive gene action was cumulative positive gene, it's causing the heterosis of hybrids, this allows plant breeders to select outstanding species from an early

generation, allowing progress in selection and genetics to be in equilibrium or fixed, quickly. Therefore, this was suitable for selecting plants, that self-pollination, that need to be inbred line, which will have the stability of the genes in different positions from one generation to another and showing stable results in various environments as well (Kankaew, 2011).

Non-additive gene action was an expression of uninterrupted genes like the accumulation of positive gene expression, the expression of hybrid was clearly distinguished from the parents especially in early generations, which was difficult for prediction of progress from the selected results, since in later generations these distinctive characteristics will disappear during the generation that has been selected such as the selection to be an early variety. However, early variety characteristic will be expressive in F_1 hybrid (Kankaew, 2011). When selected in a later generation, early variety characteristic will gradually disappear, eventually becoming late variety characteristics instead. Non-additive gene action, divided into 3 types: complete dominance, incomplete dominance and over dominant (Brown, 2008).

Hughes (1948) Reported that in Honeydew and Smith's Perfect line, there are w genes that control the white peel, which is recessive characteristics to the dark green of peel color. Two genes that control the nets on the peel are the *N gene* that controls nets and *gene n* controlling smooth peel effect (Ramaswamy, 1997).

Hughes (1948) were quoted in Kachane (2008) Reported that the genes control the green pulp being suppressed by the orange pulp genes control in Honeydew and Smith's Perfect.

Lumsden (1914) were referred to in Nonnecke (1922) Described breeding between muskmelon, to studies the expression of the F2 hybrids, found that yellow peel color which controlled by dominant genes, green color was controlled by recessive genes, rough surface with reticular nets was controlled by dominant genes, smooth surface without nets was controlled by recessive genes, round shape was controlled by dominant genes, oval shape was controlled by recessive genes, large size of fruit was controlled by dominant genes, small size of fruit was controlled by

recessive genes, large size of seed was controlled by dominant genes, and small size of seed was controlled by recessive genes.

Pornsuriya (2012) Estimate of gene action on fruit characters of 2 Thai melon lines. Found that the additive gene effects were significant controlling days to male anthesis, days to first harvest and fruit cavity width, whereas dominance gene effects were more important than additive gene effects in controlling days to male anthesis, days to first harvest, fruit length, fruit cavity length and fruit flesh thickness. Non-allelic gene interactions were significant in fruit width, fruit length, fruit cavity length and fruit pulp thickness, and dominance x dominance type of gene action was most important in controlling these characteristics.

2.6 Combining ability test

The combining ability test was selection population step or inbred line selection of many lines with many inbred lines. Once a hybrid is made, may be not matched to the breeding objectives (Patthum, 2001). The final breeding objective, to create hybrid in cross-pollinated plants. To produce hybrids, which may get a perfectly good, inbred line can produce to hybrids or totally fail. This depends on the choice of parent lines and breeding method. Genetic differences are observed, which results in high-yield hybrids with high variability in the genetic characteristics of their hybrid. Conversely, if the parents have similar genetic characteristics, the hybrids will be like their parents, hybrid in later generations will have low genetic variability, and there will be no progress in selecting new lines (Laosuwan, 2003). Therefore, in this experiment, the selected strains were used to test the potential of line, namely the combining ability test, heterosis and characteristics correlation. The combining ability test of inbred lines had 2 types. **1) General Combining Ability (GCA)** means the ability of a particular lines when cross with many other lines and then to give an average of high hybrids. And **2) Specific Combining Ability (SCA)** means the ability of a particular line when cross with other lines to give a high hybrid, it is the unique capability of those pairs: GCA is variance is the result of additive genes. There are 3 methods for combining ability test performance of a widely used lines, each method is effective, and limitations are

different. The selection of methods to suit the conditions of the work will help to save labor, budget and time and increase the efficiency of breeding as well as the following 1) topcross 2) diallel cross 3) factorial cross (Funpeng, 2010).

Griffing (1956) There were four different methods for diallel design based on whether the parents, their reciprocal F_1 hybrid or both, were included in the evaluation with the F_1 hybrid: Method I or Full Diallel Design: The method I or full diallel design consisted by parents, one set of F_1 hybrid and reciprocal F_1 hybrid. The system gives n2 genotypes. Method II: This method encompasses parents and one set of F_1 hybrid without reciprocals F_1 hybrid. This design gives n (n + 1)/2 genotypes. Method III: Here, one set of F_1 hybrid and the reciprocals are investigated. This design provides the equation a = n (n - 1) different number of genotypes. Method IV: Here, it only includes F_1 hybrid. This design provides the equation a = n (n - 1)/2 different number of genotypes.

Kamer (2015) Studies was the hybrid vigor, heritability, inbreeding depression, number of gene pairs were valued for fruit characters and yield in melon. They used half-diallel mating system to obtain 10 hybrids combinations. The results were revealed the hybrid were significant with positive heterosis and heterobelosis for all character.

Khanobdee (2016) Studies was the improvement of long fruit hybrid cucumber (*Cucumis sativus* L.) for resistance to downy mildew on increasing productivity and reducing the cost of chemicals used two methods of combined ability test follow Griffing's method I. From the diallel cross showed moderate resistance to downy mildew, stable stability with a high negative SCA of downy mildew resistance and positive SCA of fruit length.

Pornsuriya (2016) Studies was to estimate heterosis for fruit characters and yield in the inter-varietal hybrids of oriental sweet melon. They were used a half-diallel cross. The results showed that significant variety effect was observed for all characters. Heterosis effect was significant for fruit weight, fruit width, fruit shape index and yield. Overall heterosis partitioned into components showed that average heterosis and variety heterosis were significant for fruit width and fruit shape index. Specific heterosis was significant for fruit weight, fruit width, fruit shape index and yield.

2.7 Heterosis of characteristics

Heterosis of characteristics means the phenomenon that hybrids are strong, growing, giving good yield, resistant to diseases and insects, drought resistant, and have other characteristics better or higher than that of the parent lines. Heterosis of characteristics may be caused by the plant being in a heterozygous, therefore, high heterosis are found F_1 hybrids of hybrids between cross-pollination crops. Heterosis of hybrids in the same plant may had different levels if different varieties were line. Moreover, even for the same hybrids the heterosis rate in different generations will be different. The heterosis of hybrids may be measured in two ways: 1) Measured by comparing with the average of parents is a measure of the percentage of hybrid improvement against the average of their parents, this method of measurement is called outstanding above average of parents or heterosis, this method of measurement shows that such characteristics had the expression of dominant genes and 2) Measured by comparing with the average of the better parent lines, this method of measurement is a measure of the properties by using the average of the hybrids to compare with the parents that give good characteristics, this method of measurement is called heterobeltiosis (Laosuwan, 2003).

Iathet (2006) Studies the heterosis between 2 varieties of cantaloupe, found that yield per plant gave a heterosis value of 12.71%, and total yield per plant gave a heterosis value of 8.20%. Showed the hybrid between 2 varieties of cantaloupe gave yield per plant had high heterobeltiosis, and the total yield per plant was high heterosis.

Kamer (2015) Studies were the hybrid vigor, heritability, inbreeding depression, number of gene pairs were valued for fruit characters and yield in melon. They used half-diallel mating system to obtain 10 hybrids combinations. The results revealed the hybrid were significant with positive heterosis and heterobelosis for all character. Most the hybrids showed high broad sense heritability for the traits of plant length, number of branches per plant, flowering date, maturity date, fruit pulp thickness, peel color, sweetness, moisture content and vitamin C. But the traits of plant length and fruit pulp

thickness showed high narrow sense heritability. Most of the hybrids exhibited inbreeding depression for the characters of plant length, maturity date, sweetness, moisture, and vitamin C.

Pornsuriya (2016) Studies was to estimate heterosis for fruit characters and yield in the inter-varietal hybrids of oriental sweet melon. The results showed that significant variety effect was observed for all characters. Heterosis effect was significant for fruit weight, fruit width, fruit shape index and yield. Overall heterosis partitioned into components showed that average heterosis and variety heterosis were significant for fruit width and fruit shape index. Specific heterosis was significant for fruit weight, fruit width, fruit shape index and yield.

Pornsuriya (2018) Studies was the yield performance and heterosis for yield of crosses between Thai melon lines and cantaloupe testers was determined involving 4 Thai melon lines (L1, L2, L3 and L4) and 3 cantaloupe testers (cantaloupe populations: T1, T2 and T3). The results revealed that parents and crosses were significantly different in yield. The hybrid gave the highest yield, and significantly positive heterosis and significantly positive heterobeltiosis.

2.8 Correlation

Correlation refers to various aspects of related plants, relationships may be positive or negative. The relationships may increase or decrease together, or one increases but another reduces. The relationships may be caused by characteristics controlled by the same gene, or the development of a particular characteristic depends on the development of another characteristic. The relationship between characteristics may be used to assist in plant breeding. Correlation of plants, which can be divided into 3 types: phenotypic correlation, genetic correlation, and environmental correlation (Laosuwan, 2003).

Iathet (2006) Studies was correlations of fruit characters and yield in of Thai melon. They are with two inbred lines (RM1 and LM2) of slicing melon. The results revealed the fruit width correlated negatively with fruit length and the result shape index. Fruit shape and fruit size did not correlate with fruit number per plant and yield. While the number of fruits per plant had a high positive correlation with the yield per

plant. Showed that correlations between traits can be used to help improve plant varieties. Indirect selection may be conducted in multiple characteristics or in multiple characteristics at the same time. Using data from correlated studies.

Ibrahim (2013) Studies were genotypic correlation and path analyses were carried out for growth, yield, and fruit quality traits in 13 sweet melon genotypes collected from different places in Egypt. They were studying the correlation at under irrigated conditions. The results revealed the total yield per plant was positively and significantly correlated with fruit weight, fruit pulp thickness and fruit length. Positive direct effects were exhibited for fruit weight, number of fruits per plant and stem length on total yield per plant, while maximum positive indirect effects on total yield per plant were exhibited by fruit length and fruit pulp thickness through fruit weight.