Cultivation of Fig (Ficus carica L.) As An Alternative High Value Crop In Malaysia: A Brief Review

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Abstract. Fig (Ficus carica L.) is an important crop worldwide and are consumed fresh or dried and it is included in diet since the ancient years and it is considered as the symbol of longevity. It is well known for its excellent flavour, attractive colour and high nutritional value. Due to these specifications, it has been cultivated and consumed since ancient times. The published literature on cultivation of this crop is meager. Thus, the aim of this paper is to describe the agroecology, economic importance, production of the plant, and its production requirements, but major emphasis is given to the agronomic and management aspects of the plant to be grown as a crop. This paper represents as effort to compile the literature on F. carica and review the production requirement of the and its potential as an alternative high value crop in Malaysia.

1. Introduction

Ficus carica Linn. has been commonly known as ‘Fig’ and is one of the earliest cultivated fruit trees in the world. F. carica is a deciduous, perennial tree belonging to the family Moraceae, which encompasses over 1400 species classified into about 40 genera [1]. The fig tree is one of the unique Ficus species widely spread in tropical and subtropical countries which has edible fruits with high commercial value [2]. Ficus carica is usually a 15–20 ft tall tree, with numerous spreading branches and trunk rarely more than 7 ft in diameter [3]. The skin of the fruit is thin and tender when fresh and the fleshy wall is whitish, pale yellow, pink, rose, red, or purple, depending on the species. The wood of fig trees is low in density and breaks easily. Branches have a pithy interior. Latex, which is irritating to human skin, is produced from all broken plant structures [4]. The fig is juicy and sweet when ripe, gummy with latex before ripening. Seeds vary greatly in size and number from 30 to 1600 per fruit and the leaves are described as hand-shaped [5].

Particularly, F. carica L. is a gynodioecious diploid species with 26 chromosomes, bearing either hermaphrodite or female flowers on separate plants. This characteristic is important for distinguishing fig types and cultivars [6]. Fig consists of numerous varieties with significant genetic diversity and outstanding pharmacological activities that are of remarkable commercial importance. This plant also invites attention of the researchers worldwide for its biological activities. The therapeutic utilities of Ficus carica have been indicated in the traditional systems of medicine such as...
Ayurveda, Unani, and Siddha [3]. Figs are particularly healthy fruits with an excellent source of minerals, vitamins, and dietary fiber. In addition, fig fruit also contains fat and cholesterol-free with a high number of amino acids. Similarly to other fruit species, figs contain sugars and organic acids that influence their quality [7].

Most review papers to date has tended to focus on phytochemistry, pharmacology and biological activities of \textit{F. carica}. Nevertheless, the published literature on cultivation of this crop with the focused on its agroecology, economic importance, production of the plant, and its production requirements is still meager. Thus, this paper represents as effort to compile the literature on \textit{F. carica} and review the current status of understanding of the plant and its potential as an alternative high value crop in Malaysia.

2. Agroecology of \textit{Ficus carica} L.

Currently, fig fruit species is widespread in many regions since it has high adaptation to different climate and soils without any significant deficiency or toxicity symptoms of plant nutrients [2,8]. The fig can be grown to a height of 1,525 m above sea level. The fig tree requires a warm climate with hot summers and mild winters, although it can grow adequately under less favorable conditions [9]. The semi-arid tropical and subtropical regions of the world are also suitable for fig cultivation with the assistance of irrigation. It tolerates winter temperatures as low as 10°C. Fig is quite tolerant light frosts. The top growth is susceptible to frost damage and can be killed back to the base in severe winters. Figs do not require winter chilling to break dormancy. It thrives in partial to full sun in the coastal and inland areas in the lowlands and highlands. Rains during fruit development and ripening are detrimental to the crop, causing the fruits to split [10].

In tropical climate, it can be grown at a height of 800–11,200 m [11]. Malaysia’s climate has relatively high levels of temperature and humidity. The humidity varies from 80% to 90% except for highlands. Throughout the year, the temperature ranges between 22°C and 33°C (72–91°F) and the average daily temperature is 26.5°C [12]. Hiiwale stated that fig requires hot climate however, if the temperature goes beyond 39°C, the quality of the fruit deteriorates and the fruit ripens early [11]. The author also suggest that the temperature between 15°C and 36°C is ideal for the cultivation of fig. Another important aspect to be considered is that the fig requires lots of heat units to achieve good quality of the fruit which limits the expansion of cultivation in regions with low temperatures [13]. Thus, growing \textit{F. carica} in Malaysia is considered as one of the best alternative crop for fruit crop production in this country.

3. Economic Importance of \textit{Ficus carica} L.

Nowadays, fig is an important crop worldwide for dry and fresh consumption due to its international trade. According to Aksoy starting from the end of the 19th century onwards, Turkey has been the leading country both in fresh and dried \textit{F. carica} production and trade. The top ranks in world dried \textit{F. carica} production are changing in time, and developed countries (Greece, Spain, Portugal, Italy and USA) lose their competitiveness due to heavy man power demand whereas developing countries (Iran, Morocco and Egypt) emerge in the world market. The dried \textit{F. carica} production in some traditional producers as Italy and Spain or new countries as China continue with high added value products destined towards high-end markets.

The most important fig characters that are of interest to consumers are the flesh quality and its very sweet taste [8]. Figs may be processed or cooked in various ways such as commercial canning and drying of figs are actual industries of great importance. According to Lim ripe figs are also excellent for processing into fruit juice and fruit tea [10]. Besides, whole fruits can be preserved in sugar syrup, canned or processed into jam, marmalade, or paste. Furthermore, Mars points out that fig leaves can be used as animal feed [15]. Meanwhile, the dried and powdered latex is used to coagulate milk that serves for the isolation of the protein-digesting enzyme and from fig latex, Ficin is used for tenderizing meat, rendering fat and clarifying beverages. Dried figs may be physically cut, sliced, cubed or ground into paste. In fig paste production, the seeds (or hardened endocarps of the real fruits)
are either cracked or kept as intact based upon the demand. Fig bars prepared with fig paste as filling are well known snacks for many decades. Cut or cubed dried figs are mixed with nuts for snacks, with cereals for muesli or coated with chocolate. Small balls made from fig paste can also be coated with chocolate or mixed with nuts and then coated with roasted sesame seeds or grated pineapple and served as Turkish delight. Dried fig purée can be used as a raw matter in making ice cream, marmalades or juice [14]. In ethnomedicine, fruits are used in leprosy and nose bleeding, and are used as antipyretic, aphrodisiac, lithontriptic, hair- nutritive, emollient, demulcent, laxative, and in the treatment of various inflammations, paralysis, liver diseases, chest pain, and piles. Roots are used as tonic in the treatment of leucoderma and ringworm infection. Latex is used as expectorant, diuretic, anthelmintic and anemia. Leaves are used as anti-diabetic, vermifuge, and contact dermatitis in humans, phototoxicity in animals. Seeds are used as edible oil and lubricant [3].

According to Shazmin-shazwan et al. in Malaysia, fig fruit is processed into jam, tea, dipping sauce, spaghetti sauce, cake, ice cream, biscuits, chocolate, marmalade, wine and other several types of beverages. The author also stated that fig industry in Malaysia is growing in producing more products for commercial purposes rather than investing on modern pharmaceutical for medicine development. Besides marketing the fig product such fresh fruits, jam and other, the farmer also focus on planting material for propagation purpose to be sold since it has high demand and market value. The price of cutting alone can be sold up to RM30 - RM100 or more depending on the variety of fig. The global demand for this fruit as a functional food provides the possibility for small local farmers to increase their income by diversifying their agricultural offer. Hence, it is necessary to generate more knowledge in terms of the agronomical management of this crop in the country. As a complement to the rich pleasures of fresh and dried figs also the products, there is a great deal of interest in expanding fig sales in Malaysia. This will require significant advances in cultivation systems to make them more efficient and sustainable.

4. Production of Ficus carica L.

According to the Food and Agriculture Organization of the United Nations in 2014, the area planted with F. carica exceeds on 386,737 hectares, with a production of more than one million metric tons per year (FAOSTAT). The largest part of the world’s F. carica production is found in the countries of the Mediterranean coast. According to Russo, Caporaso, Padoano and Sacchi in these countries, F. carica are important constituents of the Mediterranean diet, which is considered to be one of the healthiest nutritional habit as well as being associated with longevity. Fig trees are abundantly cultivated throughout the Mediterranean region and are well adapted to drought conditions and high temperatures. Turkey and Egypt are the countries with the highest production of F. carica and represent ~43% of world production, followed by Algeria, Morocco and Iran. Turkey is the main exporter of F. carica followed by Austria, Spain, Italy and the Netherlands and the main importing countries of F. carica are France, Germany, Austria and the United Kingdom. According to Ersoy, Gok and Yilmaz commercial production of fig is carried out in countries where the Mediterranean climate prevails, such as California, Australia and South America as well as Mediterranean countries.

Figs have recently attracted a great deal of attention and are widespread throughout the world. In Asia, there are several countries, which started to planted F. carica such as China, Japan, Thailand also Indonesia. Based on the reviewed done by Lianju, Weibin, Kai, Zhifeng and Yelin the commercial production of fig increased in China as the scientific research of this fruit was conducted including cultivars selection, cultivation systems, techniques of training and pruning, management of soil, fertilizer and irrigation, as well as the technique of processing and medical use, production of fig was greatly promoted. Furthermore, the area of fig production before 1985 was about 350 hm2, and currently up to 6667 hm2, which is 20 times greater than 20 years ago. Meanwhile, the fig fruit industry in Japan is only focused on certain region with “Masui Dauphine” as the main cultivar produced in this country. In Thailand, fig production is focusing on the development of new typical
agricultural products to be offered in local markets. Thus, this will help their local growers to generate income.

In Malaysia, the Ficus carica L. tree is considered an underutilised and minor fruit species which cultivation is intended for hobby purposes. Currently, there is only a small number of F. carica orchards available throughout Malaysia. Even though, F. carica farming is still in the emerging stage but it is slowly gaining attention with many people who are fascinated with this ancient plant. Thus, F. carica have been considered to be an alternative high value crop that can generate new source of income to the farmers since it is easier to cultivate, can be harvested within short periods and give a quicker return in investment other than fruit crops. The worldwide cultivation of F. carica has achieved great economic importance, mainly due to its role as a food, medicinal and cultural purposes. This situation has generated great interest in researching its methods on production requirement.

5. Production Requirement of Ficus carica L.

Malaysia is the only country where we can have all-year-round production of figs because of our climate and at the same time having the best-quality figs. In spite of the numerous benefits presented by the cultivation of *F. carica*, there are several factors that need to be optimized in order to obtain the highest production of *F. carica* such as appropriate production system, nutrient management, water requirement and soil requirement.

5.1. Production System

The cultivation of *F. carica* is rapidly increasing in the open field and under greenhouse conditions because it is a species that responds favourably to agronomic management, so it is an excellent production alternative. *F. carica* planted in the open field production often facing some problems, such as high incidence of pests and diseases, rotting of the fruit in the rainy season and also poor management of plantations. These poor condition will severely affect growth performances and fruiting of the crops. Thus, cultivation of *F. carica* under protected cultivation will be the solution during adverse growing conditions. Greenhouse cultivation is the most intensive form of crop production with a yield per cultivated unit area up to 10 times superior to that of a field crop. A recent study performed by Mendoza-castillo et al. showed that *F. carica* grown under greenhouse condition will have more than five production cycles under this type of production system. Besides, Gruda and Tanny mentioned that growing crops under protected environment not only protect it from external natural hazards, but also allows for artificial manipulation of the crop micro-environment to facilitate optimal plant performance, extend production duration, induce earliness of flowering, and improve production and product quality. In addition, the main advantage with protected cultivation is that the production can be throughout the year, which is not possible in the open field farming due to the heavy rainfall and wind, especially in tropical regions.

5.2. Nutrient Management

Fertilization management in agriculture is important due to economic and environmental issues. Mismanagement of nutritional requirements of agricultural crops during last decades resulted in serious life and environmental challenges. Depending upon the variety, soil type, and climate of the area, the fertilizer should be applied [11]. The correct fertilization tends to satisfy the nutritional needs of the plants. However, it is necessary to minimize the application of fertilizers to reduce the environmental impact of fertilization.

Previous study by Lianju et al. reported that in the early growth season, nitrogen fertilizers such as urea, NH4HCO3 were used in the orchards where the soils were infertile and the weather was less precipitation. Potassium and phosphate fertilizers were usually spread not only more in fig orchards but also earlier than in the other fruits, because fig fruits at the lower parts of shoots began to mature
while those at the upper just at the stage of differentiation. Generally, potassium and phosphate fertilizers were used about one month before summer and autumn fruits were harvested. A study conducted by Holstein, Crisosto and Crisosto on application of potassium in two different figs cultivars which were ‘Black Mission’ and ‘Sierra’ on yield, marketable yield and fruit size has reported that substantial fertigation of potassium may increase marketable yield of ‘Black Mission’ and ‘Sierra’ fresh fig cultivars, which is imperative for the fresh fig producers since marketable yield determines revenue. Fruit size was also increased by fertigation treatment ‘Sierra’ figs, and this increase in size is related to high leaf K concentrations. Enhanced growth with improved fruit yield and quality can be obtained by the application of proper fertilizers because any nutrient either deficient or in excess can lead to a reduction in crop yield coupled with inferior fruit quality.

5.3. Water Requirement

In agriculture, it is important to produce more with less water because water is a limiting factor in many parts of the world. Irrigation water faces the double limitations of water shortage and low water use efficiency. Irrigation system is one of the most important components affecting the yield and quality of agricultural produce from greenhouse farming system. Water should be given in proper amount and accurate time application. Therefore, water management is a key to avoid plant moisture stress during the crop growth stages. Thus, the development of water efficient agriculture and the improvement of crop yield and water use efficiency have high potential as effective measures to develop sustainable agriculture in irrigated areas.

In a recent study conducted by Abdolahipour et al. reported that F. carica trees tolerated drier conditions than most fruit trees, however this plant still require sufficient amount of water for optimal performance and production. The frequency depends on some tree size, vigour, soil type and rainfall. F. carica trees are very sensitive to root rot, thus it is better to avoid major fluctuations in moisture such as excess amount of irrigation water as F. carica cannot cope well under these conditions. This study is supported by Caruso, Gennai, Ugolini and Gucci on a study to evaluate the gas exchange and growth response of F. carica plants to water deficit and relief. The researchers found that mild water deficit showed significant effects on shoot growth, leaf biomass and gas exchange parameters. Similar results were also obtained by El-Shazly et al. on several F. carica cultivars growing on different irrigation treatments. The results showed that irrigation at 75% ETc and 50% ETc decreased the values of growth rate compared to 100% ETc.

Treating the crop with water without knowing the parameters concerned will lead to facing problems, such as drainage and salinity, besides the failure to obtain the benefit expected from irrigation. Thus, the knowledge on appropriate management of irrigation is of vital importance for the growth of F. carica as it will elicit higher crop yield and rational use of water resource.

5.4. Soil Requirement

Lim stated that the fig can be grown on a wide range of soils such as light sand, rich loams, clay or limestone, providing there is sufficient depth and good drainage [10]. A heavy wet soil tends to encourage excessive plant growth at the expense of fruit production. Highly acid soils are unsuitable. The ideal pH should be between 6.0 and 6.5. Figs perform best on well-drained, reasonably fertile, organic matter rich soils. This statement is also supported by Andrade, Carvalho, Almeida, Silva and da Silva which is fig trees can adapt to different soils, but the most appropriate are those of clayey-sandy texture, rich in organic matter and pH ranging from 6.0 to 6.8. It is due to in poorly drained soils, there might be root rots while in those excessively dry, plants remain under a resting state, developing few leaves and not producing fruits.
6. Conclusions
From the review, we can made several conclusions which are;

i. Growing fig trees in unsuitable conditions may cause crop loss and various types of fruit damage. Even though this crop may thrive in different climate but some agronomic factors such as production system, nutrient management, water requirement and soil requirement may affect the yield and production of the fig tree.

ii. Creating high values for agricultural crops grown in efficient production systems is needed to ensure a high return in relation to investment costs. Thus, the right agronomic management need to be used to eradicate the problems that cause by internal and external factors and this will create an environment suitable for working efficiency as well as for better F. carica production.

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