

EARLY GROWTH AND FRUIT DEVELOPMENT OF
FIG (*Ficus carica* L.)

BY

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ABSTRACT

Fig (*Ficus carica* L.) is a member of family Moraceae that originated from the Mediterranean region. Fig is widely planted for its fruit which can be eaten fresh and dried. The demand for fig seedlings is currently on the rise amongst Malaysians, but the main problem is that there is insufficient production of fig seedlings as a result of low production scales. Propagation using stem cutting can be used as this method can contribute to large-scale production. However, there is a lack of knowledge on agronomic practices related to the propagation of stem cutting in Malaysia. Besides, fig fruit is usually imported from other countries however it can be produced in Malaysia. However, there is still no information on fig fruit production in Malaysia. This experiment aims to study the effect of different planting medium and cutting type on an early shoot and root development of *Ficus carica* and also the development of the fruit of *Ficus carica* as affected by the different rates of chicken manure. The first study emphasizes the effect of planting medium and type of stem cutting on the early growth of the shoot and root system of *F. carica*. The research was conducted in the glasshouse at the Glasshouse and Nursery Complex (GNC), International Islamic University Malaysia (IIUM) Kuantan Campus. Three kinds of media combinations of topsoil, sand, sawdust, peat, and perlite were used as planting medium. Meanwhile, two kinds of stem cuttings which were semi-hardwood and hardwood were used as cutting material. The experiment was conducted with five replications in a split-plot design. Data on the shoot and root systems were recorded and analyzed through analysis of variance (ANOVA). The root anatomical structure was prepared through a series of histological work. Samples were observed and analyzed using Leica LAS EZ software. Results showed that 50% peat and 50% perlites give the highest performance on the early growth of the shoot and root of *F. carica*. Thus, it is recommended to use the mixture of 50% peat: 50% perlite and hardwood stem cuttings as planting medium and type of cutting for early fig growth. The second study was on the growth performance of fruit affected by different rates of chicken manure. This study was conducted in the open area of the GNC, IIUM Kuantan Campus. The experiment was arranged in a randomized completely block design (RCBD) of six blocks. Four rates of chicken manure used were 0 g chicken manure (T1), 150 g chicken manure, 300 g chicken manure, and 450 g chicken manure. Data on fruit development were recorded and analyzed through analysis of variance (ANOVA) by using open software SAS. The result showed that the application of 450 g chicken manure (T4) produces the highest fruit performance compared to all treatments. Thus, it showed that a higher amount of organic fertilizer used significantly increase the fruit performance of *F. carica*.

خلاصة البحث

إن نبات التين (*Ficus carica* L.) تصنف تحت عائلة Moraceae التي تنبت في منطقة البحر الأبيض المتوسط. يزرع هذا النبات على نطاق واسع بسبب ثماره التي تؤكل طازجة وبعد تجفيفها. يزداد الطلب إلى شتلات الطين حاليًا بين الماليزيين، ولكن لا يوجد إنتاج كاف لشتلات الطين بسبب انخفاض حجم الإنتاج. يمكن زيادة الإنتاج باستخدام القطع الجذعية لأنها يمكن أن تسهم في الإنتاج على نطاق واسع. ومع ذلك، هناك نقص في المعرفة بالممارسات الزراعية المتعلقة بانتشار قطع الجذع في ماليزيا. من ناحية أخرى، يمكن استيراد ثمار الطين من بلدان أخرى ويتم زراعته في ماليزيا. على كل حال، حتى الآن لا توجد معلومات حقيقية عن إنتاج ثمار الطين في ماليزيا. تهدف هذه الدراسة إلى معرفة تأثير أنواع الزراعة المختلفة ونوع القطع على إنتاج النبتة المبكرة وتطور جذر *F. carica* وفواكهها المتأثرة بمعدلات مختلفة من سماد الدجاج، تم إجراء تجربة في مجمع الحضانة والبيت الزجاجي، الجامعة الإسلامية العالمية ماليزيا، كوانتان، حيث وتؤكد النتائج الأولى للتجربة على تأثير نوع قطع الجذعية على النمو المبكر لنظام إطلاق النار والجذر في *F. carica*. تم استخدام ثلاثة أنواع من مجموعات الوسائط من التربة السطحية والرمل ونشارة الخشب والجفت والبيرلايت كوسيلة للزراعة. وفي الوقت نفسه، تم استخدام نوعين من قصاصات الجذعية التي كانت شبه صلبة والخشب الصلب كمادة قطع. وقد أجريت هذه الدراسة مع خمس نسخ متماثلة في تصميم الانقسام. ثم تم تسجيل البيانات على تبادل لاطلاق النبتة وأنظمة الجذر وتحليلها من خلال تحليل التباين (ANOVA). وقد أعد التركيب التشريحي للجذر من خلال سلسلة من أعمال النسيجي. تم رصد العينات وتحليلها باستخدام برنامج Leica LAS EZ. أظهرت النتائج أن 50٪ من الجفت و 50٪ من البيرلايت تعطي أعلى أداء في النمو المبكرة للتصويب وجذر *F. carica*. وبالتالي، يوصى باستخدام مزيج الجفت بنسبة 50٪ مع 50٪ من قصاصات البيرلايت والجذوع الصلبة كوسيط للزراعة ونوع من القطع لنمو التين المبكر. أما الدراسة الثانية فكانت عن أداء نمو الفاكهة التي تأثرت بمعدلات مختلفة من سماد الدجاج. تم ترتيب التجربة في تصميم عشوائي بالكامل (RCBD) من ست كتل. وكانت أربعة معدلات سماد الدجاج المستخدمة 0 غ (T1)، 150 غ (T2)، و 300 غ (T3)، و 450 غ (T4) السماد الدجاج. تم تسجيل البيانات المتعلقة بتطوير الفاكهة وتحليلها من (ANOVA) باستخدام البرمجيات مفتوحة المصدر SAS. أظهرت النتيجة أن تطبيق T4 ينتج أعلى أداء للفواكه مقارنة بجميع العلاجات. وهكذا، أظهرت أن أعلى كمية من الأسمدة العضوية المستخدمة بشكل كبير زيادة أداء ثمرة *F. carica*.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it confirms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Biosciences)

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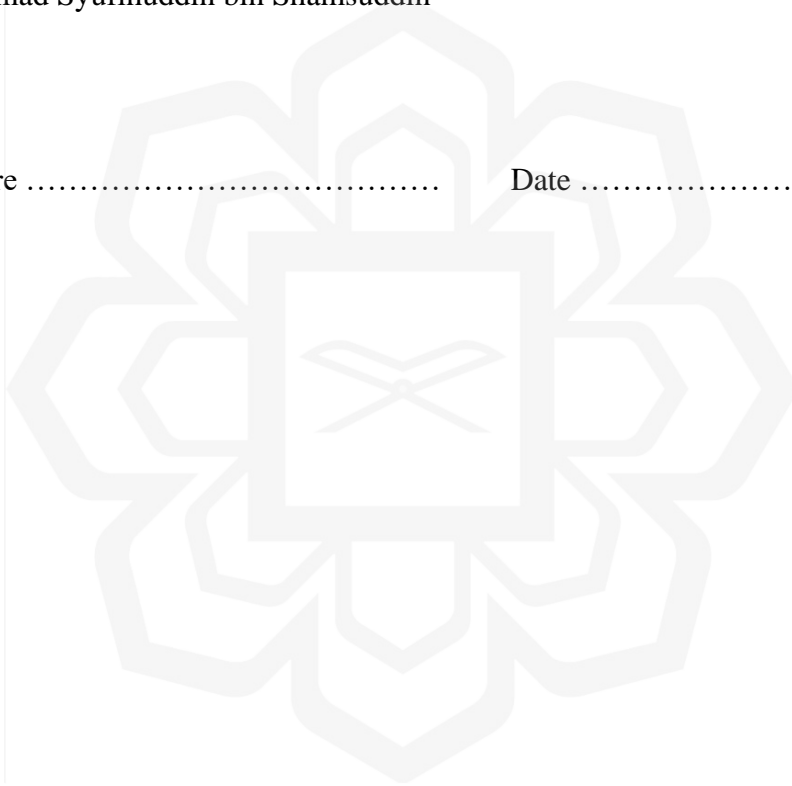
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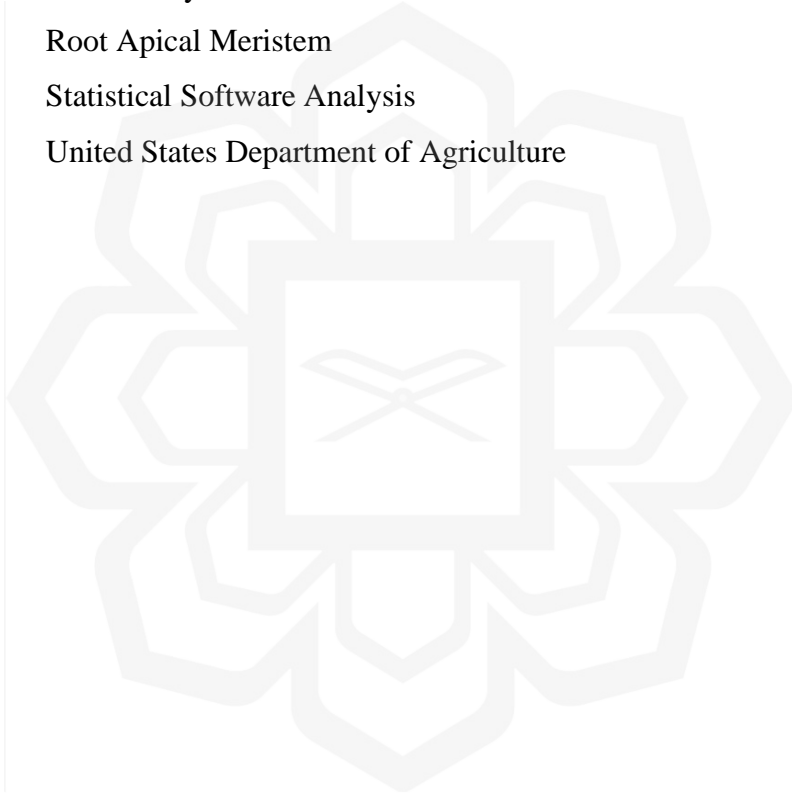
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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BTM6	Brown Tukey Modified-6
CEC	Cation Exchange Capacity
CSPMA	Canadian Sphagnum Peat Moss Association
DNMRT	Duncan New Multiple Range Test
FAA	Formaldehyde Alcohol Acetic Acid
RAM	Root Apical Meristem
SAS	Statistical Software Analysis
USDA	United States Department of Agriculture



CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Ficus is still important as it is used as food and medicine in Ayurveda and Traditional Chinese Medicine and is also used to treat many diseases and health problems such as asthma, cough, diabetes, diarrhea, gonorrhoea, heart disease, leprosy, leucorrhoea and rheumatism (Kaur, 2012). *Ficus* is also widely used as an ornamental bonsai plant, such as *Ficus retusa*. *Ficus carica* is one of the most valuable species of *Ficus* which has great potential for cultivation.

Fig (*Ficus carica*) are deciduous shrubs that can reach 4 to 15 meters in height (Andersen & Crocker, 2016; California Rare Fruit Growers, 2016; Givan, 2008; Verga & Nelson, 2014). This species originates from western Asia and has been cultivated throughout the world, such as Australia, Brazil, India, China, and Japan. *F. carica* belongs to the Moraceae family, such as Mas cotek (*F. deltoidea*) and Ara kampung (*F. auriculata*). Fig has been widely used for its nutritional and medicinal value. Fig is thought to help lower blood pressure and may have a positive effect on weight management.

Generally, this species can cope perfectly with hot and dry conditions. This edible fig also requires a good drainage system (Lawrence, 2009) but does not cope with too wet and soggy soil as it can affect roots growth (Nava, Wagner, Mezalira, Cassol, & Alegretti, 2014). In addition, the cold conditions and rain will effect crop growth and production (Flaishman, Rodov, & Stover, 2008). Fig thrive well in any kind

of soil, however different kinds of medium combinations used to plant fig will lead to a different rate of growth and development (Sahrawat, 2014). There are various types of media in growing fig such as topsoil, sand, peat moss, sawdust, perlite, and vermiculite (Bayoudh et al., 2015; Hassanein, 2013; Nava et al., 2014; Pyzner, 2005; Sirin, Ertan, & Ertan, 2010). Topsoil is a kind of media that acts as a stabilizing agent for plants. Topsoil, which is well known media, is also used in growing fig. It can hold water perfectly while the sand gives aeration for roots growth. The use of sawdust can optimize water absorption and improve crop fertility. As organic fertilizer, peat moss helps increase water and nutrient holding capacity and promotes soil worms and soil microorganisms. Perlite and vermiculite are also among the perfect media for supporting fig growth as they help with moisture retention and aeration.

All these soils and soilless media are crucial for the determination of root vigor and development, and also for the production of fruit. The root is an important part of plant growth and development. Generally, the health status of the root is reflected in the upper vegetation. Root functions include water and nutrient absorption, anchorage, food and nutrient storage, and vegetative reproduction. In other parts, fruit, the seed-bearing structures from the ovary that come after the flowering are also the main part of the plants. The fruit is one of the major categories with high demand on the global market, instead of vegetables, rice, and other food supplies. The Netherlands, United Kingdom, and Belgium are the leading direct importers of fresh fruits and vegetables from developing countries (Peperkamp, 2015).

Today, fig fruit has gained acceptance on the fresh fruit market where marketers and grow-shippers anticipate a high demand for fresh fig. Additive-free, low-sugar and natural products are the main drivers of fresh fruit consumption in the European country (CBI, 2018). In Malaysia, a few cultivation techniques are used such as by air layering

and stem cutting (Kamaruddin, Shahari, Che Amri, & Mohd Tajuddin, 2019). Current fig industry in Malaysia is growing in commercial purposes products compared to production of medicine by modern pharmaceutical (Kamaruddin et al., 2019). There are also problems faced by current growers such as cost and maintenance. Even though, Malaysia has a good future prospect as one of the fresh figs exporting countries (Marcella, 2019).

Thus, the perfect combination of potting media will improve early plant growth while the optimum amount of fertilizer used will result in the highest fruit production. Thus, it is important to monitor plant growth from an early stage and during the fruiting stage to prevent poor plant growth.

1.2 PROBLEM STATEMENTS

F. carica crop is increasingly widespread and famous in Malaysia due to its diverse value and benefit. It can be used to treat cancer, soften tissue irritations, aid digestion, chest disease remedy and improve overall health. *F. carica* originated in the Mediterranean region and is cultivated in many countries.

The demand for fig seedlings is currently on the rise amongst Malaysians, but the main problem is that there is insufficient production of fig seedlings as a result of low production scales. Aziz, (2017) stated that there are some difficulties in producing high-quality seedlings on a large-scale production. The lack of seedlings is due to poor cultivation technique. Currently, air layering method is used in fig cultivation by smallholder farmers in Malaysia, but it is not advisable. This is because the method may have a higher rate of success on early fig growth, but due to limited mother plants, it cannot produce many seedlings. There is also a method of cultivation for commercial purposes through tissue culture. However, this type of method will require a high cost

and will require a long time to produce fig seedlings. Besides, seedlings produced from tissue culture may face survival problems during the acclimatization process.

Besides, the method of propagation using stem cutting can also be used in the production of fig. This method is much easier and can contribute to large-scale production. However, there is a lack of knowledge on agronomic practices related to the propagation of stem cutting in Malaysia. Propagation by cutting involves the initial root formation of the stem. Root plays an important role in plants, especially anchorages, as well as for the transport of nutrients and water throughout cutting during early growth. Proper media selection is therefore needed to enhance healthy root development.

In the meantime, fig fruit also attracted interest among the people of Malaysia. Fig fruit is usually imported from other countries and brought back by the people who performed Hajj and Umrah. The fig tree, however, can also produce fruit in Malaysia and seen as potentially commercialized in this country (Mohamad, 2019). The production of fig fruits is different from that of the country of origin, where fig fruits are produced throughout the year due to the climate in Malaysia. However, due to problems like fruit set and unripened fruit, there is still no information on fig fruit production in Malaysia. Besides, there is no recorded information for an adequate amount of fertilizer that is needed to promote plant growth. Also, there is no accurate information to determine the best time to harvest fig. Time to harvest is important because if left too long after maturation, the fruit may damage and will not mature if harvested during the immature stage. Therefore, the stem cutting propagation method and knowledge on the production of fig fruit are needed to help improve understanding of fig among Malaysians.

1.3 JUSTIFICATION OF STUDY

The success rate of *F. carica* cuttings depends on the method used for propagation. Planting medium and cutting type play an important role in maintaining plant vigor. Without knowledge of proper planting material selection, seedlings tend to face unhealthful growth and may eventually die. The problem may also affect smallholder farmers and fig growers where seedlings cannot be grown in perfect condition and on a large scale. It will also affect them in terms of cost and time. Due to limited seedling supply, insufficient fig seedlings will also affect educational institutions, particularly on fig research in Malaysia. However, if the proper method is used, all this problem will not occur. So, we could provide Malaysians with a better understanding of how to propagate fig properly through this study. Besides, large scale production of fig seedlings can be achieved through proper techniques and simultaneously help farmers to increase their collections of the mother plant and fig crops. In the meantime, root development information can help farmers learn the best time to transplant fig when seedlings get stable.

In terms of fruit development, currently, farmers in Malaysia are growing fig crops under glasshouse conditions. It will cost farmers a great deal to build a fig nursery in Malaysia. This study can, therefore, help to gain a better understanding of the fruit formation and the time needed for the fruit to mature fully. In addition, farmers can reduce their operating costs by avoiding the use of glasshouses, as fig can grow continuously in the open field. In the meantime, Malaysia has the potential to be one of the fig export countries. Besides, the demand for fig fruit continues to increase due to an increase in the human population. Apart from that, chemical fertilizers are widely used in the agricultural sector and could lead to an unsafe environment, while the use of organic fertilizers such as chicken manure could help to improve soil resistance and

compaction resistance. The proper use of chicken manure can, therefore, help to increase the number and quality of the yield and, at the same time, reduce the time of harvesting of the fruit. Thus, the contribution and potential application of data generated from the study could improve current local production of fig in Malaysia.

1.4 RESEARCH OBJECTIVES

The objectives of this study were set: -

1. To study the effect of different planting medium and cutting type on an early shoot and root development of *Ficus carica*.
2. To study the development of the fruit of *Ficus carica* as affected by the different rates of chicken manure.

1.5 RESEARCH HYPOTHESIS

The hypothesis of this study was: -

1. The early development of shoot and root of *Ficus carica* will differs between planting medium and type of cutting used.
2. The different rates of chicken manure give different effect on fruit development of *Ficus carica*.

CHAPTER TWO

LITERATURE REVIEW

2.1 FAMILY MORACEAE

Moraceae is an angiosperm plant family (Table 2.1) comprising approximately 38 genera and more than 1000 species of woody trees (Ibrahim, 2007), characterized by milky latex in their achenes, parenchymatous tissues, ovules and unisexual flowers (Barolo, Ruiz Mostacero, & López, 2014). Many members of this family are also characterized by the presence of cystolith (enlarged cells of calcium carbonate in the epidermal cell wall) as found in *Ficus elastica* (Cutler et al., 2008). Moraceae species are divided into five tribes, one of which is Ficeae which are monotypic and geologically–present in pantropical distribution (Datwyler & Weiblen, 2004). The species of this family includes *Artocarpus altilis* (breadfruit), *A. integer* (jackfruit), *F. benjamina* (weeping fig), *Ficus* sp (fig). And *Morus* sp. (mulberry) (Crane, Balerdi, & Maguire, 2010).

Table 2.1 Taxonomical Classification of Common Fig in Taxonomic Rank (USDA, 2016)

Rank	Scientific Name	Description
Division	Magnoliophyta	Flowering plant
Class	Magnoliopsida	Dicotyledons
Order	Urticales	
Family	Moraceae	Mulberry family
Genus	<i>Ficus</i> L.	Fig
Species	<i>Ficus carica</i> L.	Edible fig

2.2 GENUS *FICUS*

Ficus is one of the largest angiosperm genera in the Moraceae family, comprising approximately 750 species (Zavodna, Arens, Van Dijk, & Vosman, 2005) that have been distributed globally (Berg & Corner, 2005) in subtropical and tropical regions (Rønsted, Weiblen, Clement, Zerega, & Savolainen, 2008). Berg & Wiebes (1992) reported that *Ficus* is one of the most diverse genera of woody plants, including climbers, creepers, hemiepiphytes, shrubs and trees (Frodin, 2004). Janzen (1979) also concludes that *Ficus* is one of the most distinctive genera of tropical plants. *Ficus* has several characteristics, including –dense branching, milky sap, leathery hard leaves (Ibrahim, 2007) and specialised syconia, divided into two systems which are monoicous and gynodioicous (Janzen, 1979; Wiebes, 1979). The syconia is a hollow structure consisting of numerous tiny separate male and female flower lining on the inner surface (Brien & Hardy, 2002).

2.2.1 Morphological Study of *Ficus*

Species in these genera are all woody, ranging from climbers, shrubs and trees (Neal, 1965). The aerial roots of most *Ficus* species descend to the ground (Chawla, Kaur, & Sharma, 2017). *Ficus* species specifically characterised by their large quantities of latex that can be found in their bark, branching and leaves. Its hood-like stipules presence on the twig tips covering new buds and the twigs have ring scars left by the fallen off stipules. The specialised reproductive structure called syconium forming internal inflorescences containing numerous small flowers that later develop into fruits (Burrows & Burrows, 2003). *Ficus* flowers are unisexual (Parrish, Koelewijn, & Van Dijk, 2004) and may be either dioecious (separate male and female plants) or gynodioecious (consist of hermaphroditic and female plants) such in *F. carica* (Verga

& Nelson, 2014). *Ficus* breeding system is still interesting as there is a close mutualisation of pollination with Agaonidae wasps (Parrish et al., 2004). Jousselein, Rasplus, & Kjellberg (2003) stated that the inflorescence character of *Ficus* species are considered adaptation to the pollinators.

2.2.2 Ecological Study of *Ficus*

Ficus is widely distributed in most of the tropical and subtropical regions of the world (Shi, Hu, Xu, & Liu, 2014) originating in the tropical regions of America, Africa, Australia and Asia (Bercu & Popoviciu, 2014). *Ficus* is grown as a houseplant in cold and temperate regions (Preda, 1979). *Ficus* can also be found on the Arabian Peninsula, the Indian Ocean Islands and Madagascar (Berg & Corner, 2005). *Ficus* species are primarily distributed in warm and temperate climates and considered to be the most diverse genus in the world (Kumar, as cited in García-Ruiz, Mendoza-Castillo, Valadez-Moctezuma, & Muratalla-Lúa, 2013). In Afrotropical regions there are currently 112 *Ficus* species identified, 36 of them are from South Africa (Van Noort & Rasplus, 2004-2012).

2.2.3 Uses

Ficus plays an important role in the biodiversity of rainforest ecosystems and is widely cultivated throughout the world due to its high nutritional and economic value (Mawa, Husain, & Jantan, 2013). *Ficus* species is also known for its ethnobotanical values and acts as a key component of tropical forests (Shi, Hu, Xu, & Liu, 2014). Danthu, Soloviev & Sarr (2002) reported that *Ficus* can be used in a variety of things, including vegetable and fruit for local people, firewood, fodder and traditional medicines such *F. thonningii* used for the treatment of malaria and yellow fever. However, only *F. carica* (fig) and