EFFECT OF GOAT MANURE ON THE GROWTH, YIELD AND FRUIT QUALITY OF TOMATO (*Lycopersicon esculentum)*

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURAL SCIENCE WITH HONOURS

HORTICULTURE AND LANDSCAPING PROGRAMME
FACULTY OF SUSTAINABLE AGRICULTURE
UNIVERSITI MALAYSIA SABAH

2017

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN TESIS

JUDUL : Effect of Goat Manure on the Growth, Yield and Fruit Quality of Tomato (Lycopersicum esculentum)

IJAZAH : Ijazah Sarjana Muda Sains Pertanian dengan Kepujian (Hortikultur dan Landskap)

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ACKNOWLEDGEMENT

First and foremost, I praise God, the almighty for giving me this golden opportunity and granting me to be able to proceed this thesis writing successfully. I would like to express my sincere thanks to the lecturers, laboratory assistants as well as the farm workers and staffs for their assistance and guidance during this Final Year Project (FYP 2) at Universiti Malaysia Sabah (UMS), Faculty of Sustainable Agriculture (FSA) Sandakan. I would like to express my deepest appreciation to my dedicated and helpful supervisor, Prof. Dr. Abd. Rahman Milan for his patience, immense knowledge, continuous support and guidance in regard to my research and during the completion of this thesis.

I would also want to thank Dr. Mohammadu Boyie Jalloh for his help and guide in the analysis of data using SAS. In addition, I am also want to thank these two laboratory assistants Miss Nurul and Mr Mohd. Rohizan bin Basir and farm assistant, Miss Cik Dg. Sitti Aminah binti Kennedy whom have help me to prepare all the necessary materials and tools for this study.

I am also grateful and very thankful to my beloved parents for being very supportive and motivating me in making this work possible. Last but not the least, I would like to thank and offer my regards to everyone who had been involved either directly or indirectly upon the completion of this thesis.

ABSTRACT

A field experiment was conducted at the Faculty of Sustainable Agriculture field in Universiti Malaysia Sabah, Sandakan campus, to investigate the effect of goat manure on the growth, yield and fruit quality of tomato (*Lycopersicon esculentum*). The objectives of the study are to investigate the effect of goat manure on the growth, yield and quality of fruits of tomato. Moreover, this study was carry out to investigate the optimum rate of goat manure application on tomato plants to achieve optimum production and quality of fruits produce. Experiment were carried out in a Completely Randomized Design (CRD) with 5 treatments and 5 replications. Several parameters for growth such as growth: plant height (cm), stem diameter (cm) and number of branches of tomato were recorded. The yield parameter are the number of fruit per plant and the total fruit weight (g) were also recorded. The fruit quality parameter of the tomato are the single fruit weight (g), number of seeds per fruit, diameter of fruit (cm) and length of fruit (cm). The data collected were also analysed by Analysis of Variance (ANOVA). Results obtained indicated that growth, yield and fruit quality of tomato at its optimal in treatments of higher rate of goat manure application per polybag, which are from T4 (30.72g), T5 (40.96g) and T6 (51.2g). Comparatively, the treatment with lesser rate have lower growth, yield and fruit quality. Based on the application of 20 tan/ha of the experiments, it could be deduced that the goat manure does helps promote growth, increase yield as well as have higher quality tomato. Thus, farmers that are herding livestock may use the goat manure as a source of organic fertilizer for their horticultural crops, and applied integrated farming as well when possible.

KESAN TINJA KAMBING TERHADAP PERTUMBUHAN, HASIL DAN KUALITI TOMATO (*LYCOPERSICON ESCULENTUM*)

Satu kajian telah dijalankan di bawah rumah teduhan hujan di kawasan Ladang, Fakulti Pertanian Lestari, Universiti Malaysia Sabah, Kampus Sandakan, untuk mengkaji kesan tinja kambing terhadap pertumbuhan, hasil dan kualiti tomato (*Lycopersicon esculentum*). Objektif kajian ini yang pertama ialah bagi mengkaji kesan tinja kambing terhadap pertumbuhan, hasil dan kualiti tomato dan bagi mengkaji kadar optimum pembajaan tinja kambing yang sesuai di tabur terhadap tomato agar pokok tersebut mencapai penghasilan yang optima dan berkualiti tinggi. Keputusan akan dinilai menggunakan beberapa aspek seperti pertumbuhan. Pertumbuhan akan dinilai melalui tinggi pokok (cm), diameter batang pokok (cm) dan bilangan dahan pokok. Seterusnya ialah, hasil pokok. Hasil pokok tomato dinilai melalui bilangan buah terhasil dalam satu pokok dan jumlah berat keseluruhan buah yang terhasil daripada setiap rawatan. Selain itu, data yang ketiga ialah melalui kualiti buah tomato. Kualiti buah akan dinilai melalui berat untuk satu buah bagi satu pokok (g), bilangan biji yang terdapat di dalam setiap buah, diameter buah (cm) dan juga panjang buah (cm). Data-data ini telah dianalisa menggunakan ANOVA sehala. Hasil kajian yang dijalankan mendapati pertumbuhan, hasil dan kualiti buah tomato menunjukkan peningkatan yang optima apabila tinja kambing digunakan dalam kadar yang berikut; T4 (30.72g), T5 (40.96g) and T6 (51.2g). Hal ini secara tidak langsung menunjukkan bahan rawatan yang menggunakan kadar tinja yang rendah kurang menunjukkan pertumbuhan, hasil dan kualiti buah yang lagi tinggi. Berdasarkan kajian ini, aplikasi tinja kambing untuk 20 tan per hektar, dapat disimpulkan bahawa tinja kambing sememangnya memberikan kesan yang positif terhadap pertumbuhan pokok, hasil dan juga kualiti yang baik untuk tomato. Maka, petani-petani yang menternak haiwan ternakan boleh menggunakan tinja haiwan sebagai sumber baja untuk ditabur kepada tanaman dan sayuran, sekaligus mengaplikasikan ladang sistem integrasi sekiranya dapat dilaksanakan.

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LIST OF SYMBOLS, UNIT AND ABBREVIATION

%	Percentage
=	Equal
≥	More or equal to
°C	Degree celcius
α	Alpha
β	Beta
ANOVA	Analysis of variance
B	Boron
BER	Blossom-end-rot
Ca	Calcium
cm	Centimeter
CRD	Completely Randomized Design
Cu	Copper
dS	DeciSiemens
EC	Electrical conductivity
EM	Effective microorganism
FAMA	Federal Agricultural Marketing Authority
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agricultural Organization of the United Nations
FSA	Faculty of Sustainable Agriculture
FYM	Farmyard manure
g	Gram
GDP	Gross Domestic Product
ha	Hectare
H_a	Alternative hypothesis
H_0	Null hypothesis
IMO	Indigenous microorganism
K	Potassium
kg	Kilogram
Mg	Magnesium
mm	Milimeter
MOA	Ministry of Agriculture
N	Nitrogen
P	Phosphorus
RM	Ringgit Malysia
S	Sulphur
UMS	Universiti Malaysia Sabah
WAT	Week after transplanting
Zn	Zinc

LIST OF FORMULA

CHAPTER 1

INTRODUCTION

1.1 Background of Tomato (*Lycopersicon esculentum* L.)

Agriculture remains as an important economic sector in Malaysia which has a significant impacts to every citizen eventhough that this sector contributes relatively lesser compare to the other economics sectors to the national food security and socio-economic development. As an example, in 2010, agricultural sector has contributed 7.3% to the Gross Domestic Product (GDP) (Department of Statistics Malaysia, 2011), and the figure dropped to 7.1% in 2013 (Malaysia Productivity Corporation, 2014). Despite of this, there was little positive contribution of output and productivity exhibited in each state. According to Department of Statistic Malaysia (2011), in Sabah alone, 22.9% to 28.8% of the state GDP was contributed by the agricultural sector during 2006-2010.

Furthermore, together with Sarawak and Johor, Sabah had also been regarded as one of the main contributors to the national agriculture GDP as Sabah contributed 17.9% to overall national agricultural in 2010 (Malaysian Productivity Corporation, 2014). The 3 main crops which are rubber, palm oil, and cocoa have dominated agricultural exports ever since, albeit the Malaysian quota of the world's engenderment of these crops drop steadily during the last 2 decades. In addition to these products, farmers in Malaysia have engender a number of fruits and vegetables for the domestic market, which include bananas, pineapple, rice, coconuts, durian, rambutan, tomato and others. Tropical climate in Malaysia is very auspicious for the engenderment of diverse kind fruits as well as vegetables (Malaysian Productivity Corporation, 2014).

Statistically, listed as the ten most major fruits and vegetables in terms of consumption, tomato,which is also know as *Lycopersicon esculentum*, with an estimation of 124.4 million tons of tomato fruits harvested each year all over the world (Maul,1999;

Food and Agriculture Organization, FAO 2004; Zhang *et al.*, 2008). Apart from that, statistics engenderment quantity (tons) of tomatoes of Malaysia have shown positive transmutes which is 35,638 tons in 2007 increases to 129,572 tons in 2012, by the Food and Agricultural Organization of the United Nations (FAOSTAT 2013).

FAOSTAT (2013) ranked Malaysia as the 71st country, in term of tomatoes consumption as food. Tomatoes have a great significance not only because of the substantial amount consumed, but additionally because of their high health and alimental contributions to human well-being. Therefore, tomatoes and tomato-predicated foods may provide an appropriate matrix by which nutrients and other health-cognate food components can be supplied to humans. On top of that, it is scientifically proven that tomato consumption has been shown to reduce the jeopardies of cardiovascular disease, lower risk of developing digestive track and several types of cancer, such as cancers of prostate, lung, and stomach (Giovannucci, 2002; Canene-Adams *et al.*, 2005).

These protective consequence may be due to the ability of lycopene and other antioxidant components to avert cell damage through synergistic interactions (Friedman, 2002; George *et al.*, 2004). Willcox *et al.* (2004) mentioned that, most of the time, products of tomatoes are being produced would be processed as a form of puree, ketchup sauces, juice, paste and soups, which include 80% from the tomato overall production. Offord (1998) reported that fresh tomatoes are a consequential source of vitamin C (220 kg^{-1}), providing up to 40% of the recommended dietary allowance. Numerous health experts also have sugggested to incrementing the level of dietary lycopene and vitamin C through the consumption of tomato products and fresh tomatoes (Sanchezz-Moreno *et al.*, 2008).

Thus, in order to compose an efficient way to improve health conditions as well as to reduce the risk of cancer, which have become one of the incrementing burden upon community nowadays, it is important to enhance the nutrition of tomatoes and tomato products. 93-95% of tomatoes are composed of dihydrogen monoxide. 5-7% of the other constituents are consists of the inorganic compounds, organic acids, sugars, solids insoluble in alcohol, caretenoids and lipids (Giardano and Silva, 2000; Sanchezz-Moreno *et al.*, 2008).

Carotenoids also have their nutraceutic property that essential to human. Red colour of the fruit is affected by the carotenoid present and it constitutes of 75-83% of total carotenoids. Other than that, for the yellowish colour and representing 3-7% of the remaining, is influence by the present of the β-carotene pigment (Dorais *et al.*, 2001) (Sanchezz-Moreno *et al.*, 2008).

Vitamin C that contain in the tomatoes plays a paramount role in human body system. Adequate amount of Vitamin C in body avails the rejuvenating of wound more quicker, increment the immune system towards virus and bacterial attacks as well as reducing cholesterol level in the bloodstream. Ulser in the mouth, bleeding of gum, pain in the bone and stress are the consequences of being lack of vitamin C. The characteristic of high vitamin C level is an inherited one and can be shift into cultivated tomatoes varities (Zhang *et al.*, 2008).

1.2 Justification

If we look upon Malaysia itself, through the statistic of production quantities (tons) of tomatoes from the year 1961 until 2013 showing that increases production throughout the years by Food and Agriculture Organization of the United Nations (FAOSTAT, 2013).

As population increases, the demand is also increases and hence, improvement of the tomato production is essential to meet the market demand. The change of eating habit and life style as due to more people are health conscious nowadays, is one of the reason of this increasing demand. It was proven as from the rise from 27.3 kg in 1982 to 39.3 kg in 2000 per capita consumption, which then continue to rise again to 45.8 kg in 2001 and therefore, lead to increasing in domestic demand. Hence, the production of tomatoes should be encouraged among local growers in Malaysia or every local state as to keep domestic tomatoes industry to remain viable at competitive price in the future.

Tomato is choosen for my study due to its high nutritive value at which it contain high levels of β-carotene and Vitamin C. In fact, there are a lot of variety of tomatoes that are available on Malaysia that have been cultivated, hence it is easily available for this study. Besides that, this study also focusing on using goat's manure, which is being apply towards the tomato plants at different rates. Instead of using commonly used organic fertilizers such as chicken dung, this is to evaluate the potential utilization of

goat's dung in providing the essential nutrient that are required for the growth development, yield and quality of fruits tomato produced as well as enhancing the soil fertility.

This manure of ruminants are readily available either in processed form or in raw material. Faculty of Sustainable Agriculture (FSA), Universiti Malaysia Sabah (UMS) have provided the manure that have been collected from the goat pen. This abundant raw materials for study on tomato production is eco-friendly and easily degradable, therefore serve a platform to improve the performance of the fruit crop without harming the environment. Thus, this study will be carried out to determine the optimum application rate of goat's dung and the results obtained may be used to improve the tomato production.

1.3 Objectives

The objective of this study are:

1) To investigate the effect of goat manure on the growth, yield and quality of fruits of tomato.
2) To determine the optimum rate of goat manure application on tomato plants to achieve optimum production and quality of fruits produce.

1.4 Hypothesis

H_0: There is no significant different on the growth, yield and quality of tomato with the application of the goat manure.

H_a: There is some significant different on the growth, yield and quality of tomato with the application of the goat manure.

CHAPTER 2

LITERATURE REVIEW

2.1 Tomato *(Lycopersicon esculentum)*

2.1.1 Classification of Tomato

Tomato is being categorized under the genus *Solanum*, which identical to family, *Solanaceae*, as potatoes. Normally, wild tomato species have small fruits, and just the red ones can be eaten. Tomatoes does not really stand extreme frost, therefore it become annual in cold weather, but as perennial in subtropical and tropical regions. In addition, tomato plant flowers regardless of day length.

Eventhough the native tomato plants are not self fertile, but that is not the case for the cultivated varieties,as they are self fertile. In order to change the capability of the flower to be inherently self-pollinated as well as shorten down the flower style length, breeding was being done. Apart from that, fruit size will get bigger through breeding. Eulycopersicon (red fruit) composed of three species in the subgenera (Jones, 2007);

Table 2.1 : There species in the subgenera of *Lycopersicon esculentum*

Species	Common name	Chromosome Number
Lycopersicon esculentum sub-sp. esculentum	Tomato	24
Lycopersicon esculentum sub-sp.cerasiforme	Cherry tomato	24
Lycopersicon pimpinellifolium	Current tomato	24

Source: Jones, (1999)

Based on the the wide presence of *Lycopersicon esculentum cerasiforme* in Central America, it was consider truthful to be the predecessor of cultivated tomato. There are six species in the subgenera *Eriopersicon* (green fruited). They have chromosomes number of 24, and all are wild species which comprise of *Lycopersicon peruvianum, Lycopersicon hirsutum, Lycopersicon cheesanii, Lycopersicon chilense, Lycopersicon chmielewskii, and Lycopersicon glandulosum* (Smith, 1994; Jones, 2007).

Nowadays, from the outcome of breeding to thrive certain plant distinctive characteristics such as stress, insect and disease resistances, as well as fruit characteristics such as elongated shelf life, uniform size and coloring, and firmness, most of the tomatoes being grown today are hybrids species. Before the hybrids were introduced in the mid-1940s, the primary types grown are "open pollinated varieties. Seeds from hybrid fruits will not produce the same plant from which it was preserved, eventhough one can save the seeds from open pollinated varieties and obtain the same plant (Jones, 2007).

2.1.2 Botany of Tomato

Lycopersicon esculentum var. *esculentum* is the major plant of profit-oriented attention, with significant variability in term of size, colour and form of fruits. Commonly known as cherry tomato, or *Lycopersicon esculentum* var. *cerasiforme,* that have diameter of range 2-5 cm and the fruits are normally small. Besides, with an average length of 4 cm, pear-shaped fruit used to described *Lycopersicon esculentum* var. *pyriforme.* Other than that, known as 'potato leaves', *Lycopersicon esculentum* var. *grandifolium* have huge leaves with few follicles (Jones, 1999).

Due to the convenience and stability of the nomenclature, the continuation of the name *Lycopersicon* has been justified. Transferred of *Lycopersicon* to *Solanum* sect. *Lycopersicon* were done by Spooner *et al.* (1993) due to this basis and not only that, they also suggested new combinations of names for lots of the species of *Lycopersicon* (Jones, 1999). Tomato plant has a feasible centre of variation along the Pacific coast between the Equator and north of Chile, as to the origin, involving the Andes mountain range. Nevertheless, Indian tribes go through the domestication and cultivation, who have inhabitated Mexico (Giordano and Silva, 2000).

2.1.3 Morphology of Tomato

Tomato is consist of the root, stem, leaves, flower and seeds part. Tomato plant can reach up to 2 - 3 meter in height. The stem of tomato is green in colour, having branches and hairy. Young tomato plant normally have a round shape stem and a fragile texture, but it change to to become woody stem and hard as they grow matured. Besides, the texture of the stem is soft hairy-like. It also have a strong primary root, a lot of vibrous root and able to penetrate into the soil up to 30 - 70 cm depth (Bambang, 2008).

Leaves of tomato is green in colour, hairy and have a lot of differences in size and shape. The length of leaves are between 20 – 30 cm and width of 15 – 20 cm. Most of the leaves grow at the end of the stem or branches. Leaves stalk are round in shape elongated up to 7 – 10 cm and have a thickness between 0.3 – 0.5 cm (Bambang, 2008).

Tomato flower is yellow in colour and will produce its flower bud about 5 – 10 times that are arranged that are arranged in a bunch of flower and the branch or stick. But, this arrangment are depends on the type of tomato. The flower have 5 petals with a spoon-shaped and white in colour. It consists of the stamen (male part) and ovary (female part). The style is quite long (3 – 5 cm) and at the tip is the rounded stigma, which is orange in colour. The pollination is self pollination without any help of the pollination agent except for the pollination to produce different clone (Bambang , 2008).

The seeds are flat-shaped, hairy and covered with the fruit flesh. It is white in colour, yellowish-white, brown and dark yellow and it weigh about 2.5g/1000 seeds. Tomato seeds are normally use for the seedling process. Tomato have a lot of differences in term of size, shape and taste. Some of the tomato are round in shape, flat rounded or oval shape. Besides, there are tomato that are green in colour when they still young and red, yellowish red or dark red when they are matured (Bambang, 2008).

The tomato fruit have different shape. The difference can be seen through the type of the tomatoes. First, the Common tomato (*Lycopersicum esculentum Mill*, var *Commune Bailey*). The shape is irregularly flat, a bit furrow especially on the stalk part. It can be found on the local market in Malaysia. Second is the apple or pear tomato (*Lycopersicum esculentum Mill*, var. *pyriforme Alef*). It is rounded just like the shape of apple or pear. Next, tomato with large leaves (*Lycopersicum esculentum Mill*, var. *Commune Bailey*) (Bambang, 2008).

Round in shape, large and dense. The size of the fruit is bigger compare to the apple tomato. The fourth type is, tomato that are growing in a upright manner (Lycopersicum esculentum Mill, var. validum Bailey). The fruit is elongated and have a hard texture. The leaves are lush, frizzy and dim in colour. It grows vertically with the stem diverted upright. In addition, cherry tomato (*Lycopersicum esculentum Mill*, var. *cerasiforme* (*Dun*) *Alef*) is another type of tomato available. The fruits are relatively small compared to the other tomatoes, round or elongate. Red or yellow in colour. It as originated from Peru and Equador (Bambang, 2008).

Based on the growth charactheristics of the tomato, it can be classify into three (3) type of growth pattern. First is Determinate. The plant grows in an upright manner. The flower and fruit grow at the end part of the plant. It may be harvested in short period of time and the stem grows rapidly. Next is Indeterminate. The tomato plant grows while creeping. The flower and fruit does not grow at the end part of the plant. It takes more time to be harvested and the stem grows slowly. The third growth is Semi Indeterminate. The tomato plant grows both in upright and creeping manner (Bambang, 2008).

2.1.4 Nutritional value

Tomato have a lot of important properties which include rich in potassium, eventhough tomato may not abundant in vital nutrients for human beings (Grierson and Kader, 1986). Benefits of potassium are such as in monitoring of one's contractions of heart muscle, regulating the blood osmotic pressure as well as the kidney function (Anderson *et al.*, 1998).

In addition, Carotenoid is also exist in tomato. Classified as a class of micronutrients discovered primary in tomatoes (*Lycopersicon esculentum*), mostly used as to do some related research, as it have the interrelation in hindering prostate cancer and cardiovascular infection (Giovannucci *et al.*, 2002).

Tomatoes have distinct abundance of particular carotenoids, mainly lycopene, ever since tomato is one of the food mainly put in human diet. Tomato as well as tomato-based products provide about 9 out of 14 carotenoids present in human serum (Khachik *et al.*, 1995).

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