EFFECT OF NITROGENOUS FERTILIZER AND VERMICOMPOST ON FIELD PERFORMANCE OF *Ficus carica*

A THESIS

BY

SADIA SHAWKAT

STUDENT ID: MS-200812

A Thesis (Course No. HRT-6104) Submitted to the Agrotechnology Discipline in Partial Fulfillment of the Requirements for the Degree of Master of Science

AGROTECHNOLOGY DISCIPLINE
LIFE SCIENCE SCHOOL
KHULNA UNIVERSITY
KHULNA-9208

JULY 2022

KHULNA UNIVERSITY
LIFE SCIENCE SCHOOL
AGROTECHNOLOGY DISCIPLINE

EFFECT OF NITROGENOUS FERTILIZER AND VERMICOMPOST ON FIELD PERFORMANCE OF *Ficus carica*

A THESIS

BY

SADIA SHAWKAT

STUDENT ID: MS-200812

Approved as to Style and Contents

By

Professor Dr. Shamim Ahmed Kamal Uddin Khan
(Supervisor)

Professor Dr. Md. Yamin Kabir
(Co-supervisor)

Professor Dr. Sarder Safiqul Islam
(Chairman, Examination Committee
and
Head, Agrotechnology Discipline)

JULY 2022

DEDICATED

TO

MY

BELOVED PARENTS

ACKNOWLEDGEMENTS

First of all, the author is very much grateful to Almighty Allah who always helps author for solving any difficult situation and has enabled her to conclude this thesis.

It takes profound pleasure to express the author's sincere gratitude to her very much beloved teacher, supervisor, Professor Dr. Shamim Ahmed Kamal Uddin Khan for his cordial love, brilliant suggestions, constructive criticisms, sincere co-operations and encouragement throughout the whole period of research work and also in completing this thesis.

The author would like to extend her profound gratitude, vast appreciation and heartiest indebtedness to his co-supervisor Professor Dr. Md. Yamin Kabir, Agrotechnology Discipline, Khulna University, Khulna, Bangladesh, for his generous guidance, constructive criticisms, sincere co-operations and assistance in completion of this thesis.

The author would like to express her grateful appreciation, cordial thanks to Mrs. Rubayet Ara Deepa for her kind co-operation, invaluable help, and valuable information at the time of field experiment to complete the research work successfully.

The author is earnestly grateful to Subhankar Mondal and Md. Chanu Sheikh for all their help, assistance, guidance, co-operation and the selfless labor, they dedicated to this research work.

The author also would like to explicit her heartiest gratitude to Sheikh Nymur Rashid Lekhon and Chanchal Biswas for their helpful cooperation, useful suggestions and also to help in conducting experiment.

Special thanks are extended to the authority of Khulna University Central Library, Seminar Library of Agrotechnology Discipline, Khulna University, Khulna, from where the author found valuable information to complete the study.

Lastly, but by no means least the author would like to convey all gratitude and love to her parents, brothers, sisters, relatives, teachers and classmates for their encouragement, blessing, moral support, prayer and sacrifices which enable him to complete this thesis with patience and perseverance.

July 2022

The Author

CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ANOVA	= Analysis of Variance
BALKEP	= Balkan Ecology Project
BBS	= Bangladesh Bureau of Statistics
BCR	= Benefit cost ratio
BIRTAN	= Bangladesh Institute of Research and Training on Applied Nutrition
DAT	= Days after transplanting
FAOSTAT	= Food and Agriculture Organization Statistical Database
FNA	= Flora of North America Association
FYM	= Farmyard manure
LSD	= Least Significant Difference
USDA	= United States Department of Agriculture
VC	= Vermicompost
NF	= Nitrogenous fertilizer
SRDI	= Soil Resource Development Institute
NS	= Non-significant

CHAPTER-1

INTRODUCTION

Introduction

Ficus carica L. belongs to the order of Urticales and family of Moraceae with over 1400 species classified into about 40 genera (Baraket et al., 2009). The species of *F. carica* are shrubs or small trees and deciduous. Its roots are not adventitious, and the barks are grayish and slightly roughened. The leaves are stipulated and petiolated with obovate, nearly orbiculate or ovate leaf blade, palmately lobed, cordate base, undulate or irregularly dentate margin, acute to obtuse apex, and scabrous-pubescent surfaces (FNA, 2002).

Its common edible part is the fruit which is fleshy, hollow, and receptacle (Duenas et al., 2008). The fruit (syconium or fig) and reproduction systems of species in the genus *Ficus* are exclusive. It can only be pollinated by their associated agaonid wasps (Hymenoptera: Chalcoidea: Agaonide), and in turn the wasps can only lay eggs within their associated fruit. For successful pollination and reproduction of species of *F. carica* to occur, its associated pollinator wasp must be present. Conversely, for successful reproduction of agaonid wasps to occur, their associated species of *F. carica* must be present (Janzen, 1979). The pollinator wasp for *F. carica* is *Blastophaga psenes* (L.) (Wagner et al., 1999).

F. carica L. is an important member of the genus *Ficus*. It is ordinarily deciduous and commonly referred to as "fig". The common fig is a tree native to southwest Asia and the eastern Mediterranean, and it is one of the first plants that were cultivated by humans. Fig tree can be traced back to the earliest historical documents and features prominently in the Quran and Bible and were held in such high regard by the Greeks that laws were once created to prevent the export of fig (Lewin, 2017). The fig is an important harvest worldwide for its dry and fresh consumption. It is one of the first plants that were cultivated by humans. Nowadays, the common fig still grows wild in the Mediterranean basin. Morphological data propose that the fig is gynodioecious, whereas from a functional standing point, the fig is considered dioecious with two tree morphs: Capri fig and edible fig. Habitual fig cultivation areas have significantly decreased, and genetic variability was reduced due to disappearance of many cultivars selected in the past. Actually almost all grown cultivars are the result of old selection and are maintained by cutting as a way of vegetative propagation (Mars, 2001).

The fig tree is native to temperate regions of Asia Minor or Turkey and grown as an important fruit in the eastern Mediterranean climates, USA, and Spain. It is also cultivated as a fruit tree in the home gardens in many other regions as well (Mawa et al., 2013). In the world about 315,530 ha of land is under commercial fig cultivation. Morocco (60,533 ha) is the largest fig cultivating country in context of area under cultivation while Iran (54,200 ha) and Turkey (50,330 ha) are in the second and third position. About 5,808 ha of land is occupied by fig cultivation in India and 2,590 ha in United States (Figure. 1.1) (FAOSTAT, 2017).

Figure 1.1. Figs area under cultivation (top 10 countries) (FAOSTAT, 2017)

Fresh fig fruit is low in calories (100 g fresh fruits carry only 74 calories) but dried figs possess high energy (100 g dried figs provide 249 calories). Fresh figs contain polyphenolic flavonoid antioxidants and their antioxidant value is comparable to apple. Additionally, fresh figs contain adequate levels of vitamin A, E, and K. Fresh as well as dried figs contain B-complex group of vitamins as niacin, pyridoxine, folates and pantothenic acid. These vitamins function as co-factors for metabolism of carbohydrates, proteins, and fats (Borah, 2018).

Bangladesh has already gained self-sufficiency in food grains though there is a big gap between the need and supply of the fruit. In Bangladesh malnutrition is a common feature where each person should consume 100 g of fruit per day but we consume only 44.7 g (BIRTAN, 2013). About 54% fruits are produced during the four months of summer and rainy season and only 46% produced during the rest eight months in

Bangladesh. The most lag period for fruits in our country is November to May (BBS, 2015). Production and the availability of fruits may be improved by introducing new fruit crops as fig in the fruit cultivation schedule of Bangladesh. However, *Ficus carica* production as well as consumption is the lowest but it can play an important role to fulfill our nutritional gap.

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures and humidity. In general, maximum summer temperatures range between 30°C and 40°C. April is the warmest month in most parts of the country. January is the coldest month, when the average temperature for most of the country is about 10°C. Most parts of the country receive at least 2000 mm of rainfall per year (Weather Online, 2022). Fig thrives best in areas of moderate relative humidity and can be grown in areas of low rainfall. Fig requires some dry months particularly at the flowering and fruiting periods and some sources state that they require some winter chilling. They are light demanding plants (BALKEP, 2016). As there is a large variation in the climatic conditions between the teen fig growing countries and Bangladesh so there might have some variations related to fig cultivation and production. Hence, it is highly important to know more about *Ficus carica* production in our agro-climatic region.

At the same time, it is also well documented that, increased dependence on agro chemicals including fertilizer has led to several ill effects on human health. Singh (2006) reported that imbalanced use and ever-increasing cost of chemical fertilizers are two deterrents for enhancing productivity. In contrary, use of organic manure can improve growth, yield as well as quality of fruits. Increase in the yield of chilli, okra, tomato and brinjal by application of organic manure was reported by Gaur (1984). However, organic inputs alone will not meet the nutritional needs of crops because they contain a comparatively less quantity of nutrients compared to inorganic fertilizers, hence, the need to integrate the two forms in order to achieve better crop yield (Khan et al., 2008).

Ara et al. (2020) reported that lack of availability of good quality seedlings is the main reason as well as uncertainty about marketing is the most minor problem about farming of fig. Though *Ficus carica* is a good source of nutrients, its cultivation is not yet extended expectedly due to many limitations. It is a versatile crop adapted to different agro-climatic regions. Some works have been done on *Ficus carica* cultivation in our country but these works are not enough to stimulate the cultivation practices of *Ficus carica* in Bangladesh. The choice of fertilizers along with the fertilizer combination taken in those research works showed their effect. But still many other fertilizer combinations have been left. As per the available literature, no work has been done yet to find out the effects of the selected treatments in agro-ecological zone of Bangladesh. Similarly, researches related to *Ficus carica* production in Bangladesh is rare. Recently some exotic strains of *Ficus carica* have been collected by amateur gardeners and primarily they showed some cultivation potentials in Bangladesh (Mehraj et al., 2013). The present study was thus initiated with the general objective to evaluate the effect of nitrogenous fertilizer and vermicompost on growth and development of *Ficus carica* as well as to determine a proficient fertilizer dose for commercial *Ficus carica* cultivation.

CHAPTER-2
REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 Introduction

Ficus carica is high in natural sugars, minerals and soluble fibre as well as rich in minerals including potassium, calcium, magnesium, iron and copper and are a good source of antioxidant vitamins as A and K that contribute to health and wellness. For the nutritional value, fig is cultivated all over the world. According to FAOSTAT (2017) top fig growing countries are Turkey (305689 ton), Egypt (177135 ton), Morocco (137934 ton), Algeria (128684 ton), Iran (70730 ton), Syria (43084 ton), Spain (36380 ton), USA (28300 ton), Brazil (25883 ton) and Tunisia (22529 ton) (Figure. 2.1).

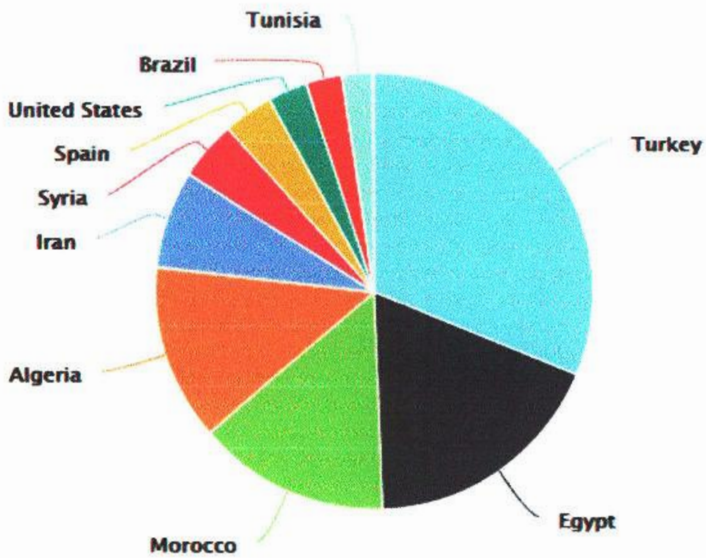

Figure 2.1. Annual worldwide fig production (FAOSTAT, 2017)

Fresh fig fruit is low in calories (100 g fresh fruits carry only 74 calories) but dried figs possess high energy (100 g dried figs provide 249 calories). However, they contain health benefiting soluble dietary fiber, minerals, vitamins and antioxidants that greatly contribute towards optimum health and wellness (Marwat et al., 2011).

Additionally, fresh figs contain adequate levels of vitamin A, E, and K. Fresh as well as dried figs contain B-complex group of vitamins as niacin, pyridoxine, folates and pantothenic acid. These vitamins function as co-factors for metabolism of carbohydrates, proteins, and fats (Borah, 2018). Dried figs are also excellent sources of minerals like calcium, copper, potassium, manganese, iron, selenium and zinc. USDA (2019) reported that, 100 g of dried figs contain 680 mg of potassium, 162 mg of calcium and 2.03 mg of iron. These nutritional supplements would be an addition in the diet of Bangladeshi people while it becomes added in the fruit cultivation schedule.

In our neighboring country like India, fresh Taiwan organic red figs are 585 ta/ kg whereas in Bangladesh Egyptian variety of *Ficus carica* is 1000 taka/ kg. It is mentionable that, in our country Taiwan organic red figs would cost more than Egyptian variety as it has not yet commercially cultivated. In the year of 2014, over 5600 ha land was occupied for fig cultivation in India (Lokappa et al., 2014). But in our country only some amateur gardeners are growing some exotic strains of fig which showed some cultivation potentials in Bangladesh (Mehraj et al., 2013). Undoubtedly the cultivated area is far less than India which is one of main reasons for higher price of this fruit in Bangladesh.

Many works have been done in different parts of the world on cultivation practices, production techniques, fertilizer effect, physico-chemical analysis of this fruit along with post-harvest methods of *Ficus carica.* But information related to *Ficus carica* plant and particularly in respect of its production is very limited. Reports related to *Ficus carica* production to both organic and inorganic farming is scanty in Bangladesh. In this light, an attempt has been made here to review literatures to formulate an approach for determining the effects of nitrogenous fertilizer and vermicompost on growth and yield of *Ficus carica.*

2.2 Effect of nitrogenous fertilizer on growth and yield of crops

One of the important tools in increasing crop yield is fertilization, especially nitrogen fertilization. Nitrogen plays a key role in the nutrition of fruit trees. It is responsible for biosynthesis of proteins, enzymes, organic nutrients, enhancing cell division and chlorophylls, building cellulose and lignin which play an important role in forming plant structure. It supports shoot and leaf area development in spring and after spring excess nitrogen moves into developing and ripening fruits. As a matter of fact, fruit trees did not produce fruits without such essential macro-element (Mengel and Kirkby, 1987; Miller et al., 1990).

Eickhout et al. (2006) and Ross et al. (2008) both observed that additional N inputs increase dry and wet (snow and rain) depositions from the atmosphere, biological fixation of N and irrigation. As crop can remove nearly 40-60% applied N, the soil residual N after harvesting can be lost to the environment through leaching, denitrification, volatilization, surface runoff, soil erosion and emission of N_2O.

Ross et al. (2008) observed that well developed management practices may lead to an increment to N-use efficiency, upsurge in soil N storage and reduction of nitrogenous fertilizer application that leads to decrease of N losses. N balance is related to N input, output and retention in soil and it helps to figure out the prominent processes of N flow in the agroecosystem.

Sainju et al. (2006) experimented the effect of Nitrogenous fertilizer on cotton and sorghum yields and N uptake. They suggested that cotton lint, sorghum grain and cotton and sorghum biomass yields and uptake of N enhanced from 0 to 60-65 kg N ha^{-1} and then stayed either at the same level or showed little increment at 120-130 kg N ha^{-1}. However, the nitrogen fertilizer requirement for optimizing cotton and sorghum yields varied with tillage and cover crop types.

Boquet et al. (2004) reported that with no-tillage cotton lint yield lower than surface tillage without applied N, but with no-tillage and optimum N rate, yields were higher. So, they pointed out that preparation of land also contributes to N-use efficiency.

Aboveground biomass yield of perennial grasses used for feedstock or bioenergy production can also be increased by nitrogen fertilization. Sainju et al. (2017) reported that yields of intermediate wheatgrass (*Thinopyrum intermedium* [Host] Barkworth and Dewey), switchgrass (*Panicum virgatum L.*), and smooth bromegrass (*Bromus inermis L.*) enhanced linearly or curvilinearly with the increment of N fertilization dose when the annual precipitation remains near or above the average.

Application of readily soluble forms of N fertilizers may cause leaching of nitrates resulting in great reduction in N uptake by plant and contamination of ground water. The loss of N via leaching through drainage water may be reduced to some extent by using slow release fertilizer seems to be very effective in improving growth and production of fruit trees (Miller et al., 1990).

Megawer (2009) showed that, application of suitable N (80g/vine) through 50 to 75% inorganic plus 12.5 to 25% organic and biofertilizers on superior grapevine, significantly improved the main shoot length and leaf area as compared with using N completely via inorganic source (100%).

There are many articles which showed the adverse effect of chemical fertilizers. Here, some studies on negative impact of nitrogenous fertilizer have been reviewed.

Problems may happen, such as nitrate pollution of ground water and environment. On the other side, huge amounts of chemicals depress the activities of both nitrogen fixation bacteria and phosphorus bacterium which only works actively, at low concentration of these substances (Waksman, 1952).

Excess chemicals can alter the composition of fruits, vegetables and root crops and decrease their contents of vitamins, minerals and other useful compounds. There is a very great danger that harmful residues may remain in food (Bogatyre, 2000).

The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching (Pimentel, 1996). So, reducing the amount of nitrogen fertilizers applied to the field without a nitrogen deficiency will be the main challenge in field management. One of the possible options to reduce the use of chemical fertilizer could be recycling of organic wastes.

Franzluebbers (2007) reported that in case of crop production nitrogen is a major limiting factor for both sustainable and profitable crop production. However, overdose of N through fertilizers and manures can degrade soil and environmental quality by enhancing soil acidity, N leaching and emissions of ammonia (NH_3) and nitrogen oxide (NO, N_2O and NO_2) gases, out of which N_2O is recognized as highly potent greenhouse gas which leads to global warming.

From a study on "the role of nitrogen in food production and environmental sustainability" by Eickhout et al. (2006) found that decreased yield is a result of excess application of N than the crop need.

Varvel and Peterson (1990) suggested that higher doses of nitrogen can show lower nitrogen use efficiency. They also suggested that one way to enhance N-use efficiency is to decrease soil residual N and hence emphasizing on lower doses of application.

2.3 Effect of vermicompost on growth and yield of horticultural crops

Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial activity that are stabilized by interactions between microorganisms and earthworms in a process called non-thermophilic process (Edwards and Burrows, 1988).

Vermicompost have large particulate surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients (Shi-wei and Fu-Zhen, 1991). It is rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes (Tomati, 1987).

Reddy and Reddy (1999) reported significant increases in micronutrients in field soils after vermicompost applications compared to those in soils treated with animal manures.

The organic composts create less environmental pollution than chemical composts due to their positive biological effect and modification of physical and chemical characteristics of the soil because their nutrients are released slowly to be used by the plant (Roe, 1997).

Oyewole et al. (2012) reported that organic fertilizers are from organic sources so they are environmentally friendly.

The organic production system targets at supporting and sustaining healthy ecosystems, soil, farmers, food production, the community, and the economy. By reducing and eliminating the adverse effects of inorganic fertilizers and pesticides on human health and the environment is a strong evidence that organic farming is gaining worldwide recognition (Aksoy, 2001 and Chowdhury, 2004).

Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Positive effects of organic waste on soil structure, aggregate stability and water-holding capacity were reported in several studies (Jedidi, 2004).

2.4 Effect of organic manures alone or combination with inorganic fertilizers on growth and yield of plants

Solaiman and Rabbani (2006) reported results and their findings on the application of a combination of cow dung and a half dose of inorganic fertilizer on tomato cultivation in Bangladesh. They suggested that 5t cow dung along with half recommended dose of inorganic nutrients showed better performance than other combinations and provided maximum return to the cultivator.

Macro-nutrients, essential micro-nutrients, vitamins, growth-promoting indole acetic acid (IAA), gibberellic acid (GA) and beneficial microorganisms are enriched in organic fertilizer is reported by Sreenivasa et al. (2010).

Ullah et al. (2010) evaluated the effect of organic, chemical and combined fertilizer doses on brinjal and found that the highest yield was gained from the combined application of organic and inorganic sources of nutrients. Yield form applied mustard oil cake or poultry manure alone gave better performance compared to only synthetic fertilizers. The organic matter content and availability of N, P, K and S in soil were enhanced by the application of organic matter. On the contrary, chemical application increased soil pH than organic fertilizers.

Bokhtiar and Sakurai (2005) reported that application of organic manure along with chemical fertilizer increased N, P and K absorption in cane leaf tissues both in the plant and ratoon crop than chemical fertilizer alone. Thus higher cane and sugar yield of both crops was obtained.

A significant increment of nitrogen, phosphorus as well as potassium uptake by application of integrated nutrient supply was observed by Singh et al. (2004) in a study on integrated nutrient management in tomato. According to them, higher yield obtained by substitution of inorganic fertilizers with organic manures, biofertilizers and crop residue to some extent.

The vigorous growth of tomato crop with early flowering and high yield obtained with the application of FYM + biogas slurry registering an increased yield of two and half times over the control NPK inorganic fertilizer application (Renuka and Sankar, 1998). Thus, it can be inferred that tomato crop would respond to application of organic manure.

To improve the tomato fruit yield through integrated nutrient management, the best combination was 100:100:100 NPK kg/ha with tons of FYM per hectare reported by Subbaiah et al. (1985).

Sendur et al. (1998) observed superior performance with respect to growth and fruit yield of tomato due to application of organic manures in combination with recommended dose of inorganic fertilizers over their individual application.

Kropisz (1992) reported that application of different sources of composts and FYM at 25 t/ha in three years field trials with cabbage, onion and carrot, the combination of FYM + NPK registered the highest yield of all three crops as compared to the application of either FYM or inorganic fertilizers individually.

Similarly, Fang and Kvonon (1994) reported that application of organic manures + chemical fertilizers significantly increased the fruit size, number of fruits per plant and yield of sweet pepper than application of chemical fertilizers alone.

Subbiah (1994) conducted a field trial to determine the effect of nitrogen, phosphorus and biofertilizers (*Azospirillm brasilense* and VAM-*Glomus faciculatum*) on yield and nutrient uptake in chilli. The study revealed that application of biofertilizers had beneficial effect on yield and nutrient uptake in chilli.

Chavan et al. (1997) found that combined application of nitrogen through FYM and urea was more beneficial compared to fertilizer alone in order to increase the yield and quality of chilli.

Malawadi (2003) found that application of NPK (100:50:50) + FYM (10 t/ha) recorded significantly higher dry chilli fruit yield over NPK alone and growth and yield components of chilli were also significantly higher with application of NPK + FYM.

Subramanian et al. (2000) opined that the inclusion of organic manures such as FYM and sunhemp in the fertilizer schedule not only increased the yield but also improved the soil moisture storage.

2.5 Effect of organic manures alone or in combination with inorganic fertilizers on soil fertility

According to Brandy and Weil (2002) soil physical properties have a profound influence on how soils can be best managed and how they function in an ecosystem. Wellstructured soils are necessary to attain sustainable and productive agricultural systems (Diaz-Zorita et al., 2004).

Changes in soil chemical conditions influence soil microorganisms, which are essential for long-term sustainability of agricultural system (Spedding et al., 2004; Wardle et al., 1999).

The beneficial effect of FYM on various physico-chemical properties of soil and to sustain higher yield levels were reported by Sudhakar (2000).

Gidnabavar et al. (1992) observed a favorable contribution of green manures like sunhemp, cowpea, blackgram, soybean and horsegram on organic carbon status of soil which resulted in possible increase in moisture retention. However organic carbon content was highest in FYM treated soil.

Hangarge et al. (2004) revealed that application of vermi-compost at 5t/h + organic booster at 1 liter per m^2 and soil conditioner (Tera care) at 2.5 t/h + organic booster at 1 liter per m^2 enhanced the availability of N, P, K and organic carbon content and perform significantly in chilli crop.

2.6 Effect of organic fertilizers and vermicompost on growth and yield of vegetable crops

A field experiment conducted in Ethiopia to investigate the influence of vermicompost on cabbage growth. There were five treatments such as 25 g/ plant□, 50 g/ plant, 100g/ plant, 200g/ plant and control (no vermicompost). The highest leaf length, leaf width, plant height and maximum number of leaves per plant and plant root was recorded at 200 g of vermicompost per plant compare to control (Getnet and Raja, 2013).

A study conducted in the garden of life Sciences Department, Manipur University Campus during three consecutive crop seasons, reported that among the six treatments they took, NPK at the rate of 70: 70: 70 kg/ ha showed maximum plant height and maximum yield (Devi and Singh, 2012).

Sohrab and Sarwar (2001) conducted an experiment and found that in case of lady's finger (okra), the vermicompost had played very effective role in all economic aspects of the vegetable crop. The yield of okra was higher from the experimental plot treated with vermicompost comparing to untreated plots.

Dauda et al. (2005b) described that one of the ways of increasing the nutrient status of soil is either by the use of organic materials such as poultry manure, animal waste and use of compost or with the use of inorganic fertilizers.

Rahman et al. (1998) experimented the good yield of berry of brinjal using animal blood meal, mustard oil cake, epil-epil leaves or the combination of these 3 in the soil's organic manures. The yield of berry was top with the united use of manures.

Ribeiro et al (1998) and Reis et al (2007) explored that the amount recommended for growing for eggplants varies usually from 5 to 40 t/ha. Cow urine is also used as a nitrogen source and presents significant levels of potassium and boron (Gadelha, 2001).

Mullens et al. (2002) discovered that poultry litters contain extensive amount of organic matter due to manure and the bedding materials.

Agbede et al. (2008) reported that poultry manure improves soil physical properties expressively by reducing soil bulk density and temperature and increase total porosity and moisture content in Nigerian soils.

Dauda et al. (2005b) reported that the application of nitrogen, a major compónent of poultry manure has been reported to improve the yield of eggplant.

2.7 Effect of organic fertilizers on growth and yield of *Ficus carica*

Kurubar et al. (2017) experimented on red sandy soils of fig orchard for two years to know the response of fig cultivar 'Poona' to different organic and inorganic sources of nutrients applied through 13 treatments in three repetitions. Fig plants which were supplemented with farmyard manure (FYM) at 8.25 t ha^{-1} + poultry manure at 2.5 t ha^{-1} + 75% of NPK fertilizer found superior with respect to fruit characters like fruit diameter, fruit length, number of fruits per plant etc. Among the various treatments, the application in combinations of various organic sources along with reduced dose of organic fertilizers improved the quality attributing characters of fig fruits. On the other hand, fig plants supplemented with FYM at 8.25 t ha^{-1} + poultry manure at 2.5 t ha^{-1} + 75% RDF found superior in total soluble solid, titratable acidity, total sugars, reducing sugars and non-reducing sugars contents. Similarly, the same treatment recorded higher gross and benefit cost ratio.

According to Osman and Abd El-Rhman (2010), application of poultry manure + azotobacter and poultry manure + azospirillum gives the highest number of new shoot, shoot length, leaf area in fig Tree (*Ficus Carica* L.).

Ertan et al. (2008) evaluated yield, shoot length and some fruit quality parameters (cull ratio, ostiole width, color, brix and acidity) and aflatoxins in a study on *Ficus carica* tree by applying different doses of N fertilizers. Fruit yield and quality says that up to 500g N/ tree can be recommended in the fertilization of fig according to their findings of two years.

2.8 Conclusion

From the above reviews, it is proved that both organic and I organic fertilizers have great impact on growth and yield of crops. Besides, combined fertilization may contribute more to the growth increment of the crop as well as it may also enhance the yield. It is also clear that the impact of fertilizer is an important tool to determine the performance of the plant. *Ficus carica* is an important fruit throughout the world and many researches have been conducted relating to this particular fruit crop. In Bangladesh, it is still an exotic fruit though some amateur gardeners are growing the fruit in a small scale. It was revealed from the discussion made above that, there is no study conducted on effect of nitrogenous fertilizer and vermicompost on *Ficus carica* cultivation in the southwestern region of Bangladesh. In light of the above reviews the present study has been attempted to investigate the impact of nitrogenous fertilizer and vermicompost on field performance of *Ficus carica*.

CHAPTER-3

MATERIALS AND METHODS

MATERIALS AND METHODS

An experiment on effect of nitrogenous fertilizer and vermicompost on field performance of *Ficus carica* was conducted at Prof. Dr. Purnendu Gain field laboratory of Agrotechnology Discipline, Khulna University, Khulna during November, 2021 to June, 2022. The details of materials used and the methods followed during the course of investigation are described below:

3.1 Material used for the experiment

Egyptian variety of *Ficus carica* is commonly known as teen which was used as plant material in this study. Fig is a deciduous, perennial tree which can rise a height of 15-20 feet tall with numerous branches (Badgujar et al., 2014). The fruit skin is thin, purple and tender when fresh and with the variation of the species, the flesh wall is whitish, pale yellow, pink, red or purple (Stover et al., 2007).

3.2 Sample collection

During the first week of January 2022, thirty seedlings of *Ficus carica* was collected from Benapol, Jashore. All the plants were of same age. Then we left the seedlings in a shady place for at least 10 days and then transplanted in the experimental site.

3.3 Experimental site

The experiment was performed in Prof. Dr. Purnendu Gain. Field Laboratory situated in Khulna university, Khulna. The experimental plot was 70 feet × 60 feet in length and width. In the experimental area, the wet season is oppressive and overcast, the dry season is humid and mostly clear, and it is hot for round the year. From January to June, the climate remains dry and warm along with 0.2 mm in precipitation and an overall clear sky. From March 12 to June 12 for three months, the area observes hot season, with an average daily high temperature above 32.78° C (91°F) while the hottest month is May. Though from February 14, precipitation starts. But from May 6, the wet season starts and continues up to October. Average 6.9 miles per hour wind speed is recorded from March 25 to June which is supposed to be the windiest month (https://weatherspark.com).

3.3.1 Land preparation

The land of the experimental site was prepared by three ploughing with power tiller and the soil of top 15 cm depth was brought to friable with the help of a hammer and spade. Weeds and other stubbles of the previous crops were collected and removed from the soil. Then it was air dried for 7 days. The physical and chemical characteristics of soil sample before applying any fertilizer and manure were analyzed at the divisional laboratory of "Soil Resource Development Institute" (SRDI), Daulatpur, Khulna (Appendix-I). The report suggested the result for both upland and wetland.

After wedding and uprooting of small and big trees, the land was ploughed for 2-3 times with power tiller. Then, planting holes were prepared for each plant at 1.5 feet in length, width and height. Into the holes the following materials were used–

- Vermicompost (6, 9 and 12 kg as per the treatment)
- Theovit (20 g in each holes)
- Bone powder (180 g in each holes)
- Furadan (20g in each holes)

The soil of holes selected for control treatment, received only the mixture of theovit and furadan. After that, the holes with fertilizer mixture were left for two months to avoid any toxic effect of the applied fertilizers on the plants.

3.4 Experimental details

3.4.1 Design

The experiment has been conducted by following Randomized Complete Block Design (RCBD) with 3 replications for the treatments. Different doses of nitrogen and vermicompost were considered as treatments. The combined fertilizers were applied in three other treatments. Under every fertilizer dose, three plants were planted to observe the performance of these plants.

3.4.2 Treatments

The experiment included 10 treatments comprising of nitrogenous fertilizer (NF) and vermicompost (VC) as follows:

T_0 = Control (soil without manures and fertilizers)

T_1 = 80g NF plant^{-1} (applied in 3 splits)

T_2 = 120g NF plant^{-1} (applied in 3 splits)

T_3 = 160g NF plant^{-1} (applied in 3 splits)

T_4 = 6 kg VC plant^{-1} (applied as basal dose)

T_5 = 9 kg VC plant^{-1} (applied as basal dose)

T_6 = 12 kg VC plant^{-1} (applied as basal dose)

T_7 = 6 kg VC (applied as basal dose) + 80g NF plant^{-1} (applied in 3 splits)

T_8 = 9 kg VC (applied as basal dose) + 120g NF plant^{-1} (applied in 3 splits)

T_9 = 12 kg VC (applied as basal dose) + 160g NF plant^{-1} (applied in 3 splits)

A treatment as control was maintained where the plants received no fertilizer. T_0 is the controlled treatment.

From T_1, T_2 and T_3, nitrogenous nutrient has been applied at the rate of 80, 120 and 160 g per plant. It was applied as urea fertilizer in three splits as follows-

- After 3 weeks of planting (along with 40g potassium nutrient, 40g phosphorus nutrient)
- After 5 weeks of the first application (along with 20g boric acid, 20g zinc sulphate)
- After 1 month of the second application (along with 40g potassium nutrient, 40g phosphorus nutrient)

In the first application and third application 40 g phosphorus nutrient (Triple super phosphate) and 40 g potassium nutrient (Muriate of potash) were applied into the mentioned two splits, respectively. In the second application all the plants were given 20 g of boric acid (boron nutrient) and 20g of zinc sulphate (zinc nutrient).

In case of T_4, T_5 and T_6 treatments, before two months of planting, the vermicompost has been applied at the rate of 6,9 and 12 kg respectively as per the treatments as basal dose. No further doses were added.

Similarly, in the treatments of T_7, T_8 and T_9, the vermicompost have been applied at the rate of 6,9 and 12 kg respectively per plant as basal dose. Later, nitrogenous nutrient of

80, 120 and 160 g per plant was added in three splits along with phosphorus nutrient and potassium nutrient. The 3 splits of nitrogen nutrient were as follows-

- After 3 weeks of planting (along with 40g potassium nutrient, 40g phosphorus nutrient)
- After 1 month of the first dose (along with 20g boric acid, 20g zinc sulphate)
- After 1 month of second dose (along with 40g potassium nutrient, 40g phosphorus nutrient)

Similarly, as T_1, T_2 and T_3, along with the first application and third application of nitrogen nutrient, 40 g phosphorus nutrient (Triple super phosphate) and 40 g potassium nutrient (Muriate of potash) were applied in the mentioned two splits respectively. In the second application all the plants were given 20 g of boric acid (boron nutrient) and 20g of zinc sulphate (zinc nutrient).

3.5 Transplanting

Healthy saplings of 60 days old were transplanted in the field on January 3, 2022. One seedling was planted in each hole. Planting was done in the afternoon. After planting, the base of seedlings was covered with soil and then the seedling beds were prepared for those 30 seedlings. Immediately after planting, the seedlings were watered.

3.6 Intercultural operations

The transplanted saplings were always kept under careful observations. Various intercultural operations were accomplished for better growth and development of the plants. The intercultural operations were as follows:

3.6.1 Irrigation

Immediately after transplanting, the crops were lightly irrigated to moisten the soil. The plants were irrigated when needed depending on the moisture status of the soil and requirement of plants.

3.6.2 Weeding

Weeding was accomplished to keep the plants free from weeds, easy aeration and for conserving soil moisture. When the plants were well established, the soil around the base of plants was pulverized.

3.7 Plant protection

Plant protection measures were taken to keep the crop free from pests and diseases. Mancer 75 WP at 2g per liter, Intrepid 10 SC at 1 ml per liter and Omite 57 EC at 2 ml per liter were sprayed on the plants at 10 days interval with the beginning of nitrogenous fertilizer application.

3.8 Harvesting

The fruits were harvested when they were fully matured and turned to purple color. Harvesting of fruits was started at 120 days after transplanting and for some plants it took up to 140 days after transplanting. This operation continued up to 150 days with an interval of 3 days. Harvesting was usually done by hand.

3.9 Collection of experimental data

3.9.1 Growth parameters

From all the plants these data were collected-

(a) Plant height (cm)

(b) Diameter of the shoot (cm)

(c) Number of leaves per plant

(d) Number of branches per plant

(e) Number of nodes per plant

(f) Leaf length (cm) and leaf breadth (cm)

3.9.1.1 Plant height (cm)

The length of plant was measured with a meter scale from the base of the plant to the terminal growing point of the main stem from third week of planting and at an interval of two weeks. The length of plant was taken in centimeters, by using a measuring scale.

3.9.1.2 Diameter of the shoot (cm)

The diameter of the shoot (cm) was measured with a centimeter tape at the base of the plant. The measurement was recorded from two weeks of planting and at an interval of two weeks.

3.9.1.3 Number of leaves per plant

At every 15 days of interval the number of leaves per plant was counted (from 15 days after transplanting) which were fully opened, matured and not senescent. It was recorded at 15, 45, 75, 105 days after transplanting by counting.

3.9.1.4 Number of branches per plant

The branches were counted at 2 weeks interval starting from 15 days after transplanting (DAT) by counting.

3.9.1.5 Number of nodes per plant

The number of nodes per plant was recorded at 15 days interval starting after 15 days after transplanting (DAT) by counting.

3.9.1.6 Leaf length (cm) and Leaf breadth (cm)

Leaf length was measured from the base of the tip point of the leaf at 15, 45, 75, 105 days after transplanting. On every interval length of 5 leaves were taken from each plant. The average leaf length was expressed in centimeters.

From each plant breadth of 5 leaves were recorded simultaneously. For calculating the leaf breadth of the leaf, three measurements were taken from the tip portion, middle portion and end portion. The average of the three portions is the breadth of leaf. To determine the leaf breadth of any particular day, average breadth of five leaves of that day was recorded.

3.9.2 Yield contributing parameters

Parameters taken under this category are-

(a) Number of fruiting shoot

(b) Number of fruits per plant

(c) Yield per plant (kg) and yield per hectare ($t\ ha^{-1}$)

3.9.2.1 Number of fruiting shoot

The number of fruiting shoot was observed at 15 days interval starting from 15 days after transplanting (DAT).

3.9.2.2 Number of fruits per plant

The fruit number was determined by the overall pickings from every single plant during April 15 to June 15.

3.9.2.3 Yield per plant (kg)

Fruit yield was determined by adding the total fruit weight over all the pickings from each treatment and was expressed in kilograms (kg).

3.9.2.4 Yield per hectare (t ha^{-1})

The fruit yield $plant^{-1}$ of *Ficus carica* was converted into per hectare and has been expressed in ton (t). It was measured by the following formula:

$$\text{Yield (ton) per hectare} = \frac{\text{Fruit yield per plant (kg)} \times 10000\ m^2}{\text{Area of plot in square meter } (m^2) \times 1000\ (kg)}$$

3.9.3 Fruit parameters

The data were collected on these parameters-

(a) Days required for bud initiation
(b) Days required for maturity
(c) Diameter of fruit (mm)
(d) Length of fruit (mm)
(e) Weight of fruit (g)

3.9.3.1 Days required for bud initiation

The first date of bud initiation was recorded for each of the plants. The observation continued after the first bud initiation.

3.9.3.2 Days required for maturity

From bud initiation to harvesting of the fruits, the days were calculated for each fruit and the average days needed to mature were determined for each treatment of the three experiments. It is pivotal for any commodity to ensure that the particular product is marketable at the right time. The fruits were harvested when they reached their desired shape and color.

3.9.3.3 Diameter of fruit (mm)

Diameter of each fruit was recorded by using digital slide calipers and the average diameter of fruits of all the treatments was calculated afterwards. The diameter was expressed in millimeters (mm).

3.9.3.4 Length of fruit (mm)

The length of all the harvested fruits from each treatment was recorded by using digital slide calipers and the average length of fruit of different treatments was recorded and expressed in millimeters (mm).

3.9.3.5 Weight of fruit (g)

The weight of all the fruits from each plant of every treatment was taken by using digital weight machine. The average weight of fruit of several treatments was measured and expressed in grams (g).

3.9.4 Benefit cost ratio

The economic indicator BCR was calculated using following formula for each treatment.

$$\text{Benefit cost ratio} = \frac{\text{Gross income (Tk)}}{\text{Total cost of production (Tk)}}$$

3.10 Statistical analysis

Collected data were analyzed for the comparison of different fertilizer doses for *Ficus carica*. Data were analyzed by using **Statistix 10** software for analysis of variance after square root transformation. ANOVA was made by *f*-variance test and the pair comparisons were performed by HSD Tukey's Test (Gomez and Gomez, 1984).

CHAPTER-4

RESULT AND DISCUSSION

RESULTS AND DISCUSSION

The findings from the current study on effect of nitrogenous fertilizer and vermicompost on field performance of *Ficus carica* have been presented and discussed in this chapter under different headings and sub-headings.

4.1 Growth parameters

Vegetative and reproductive growth of plant plays an important role in realizing potential yield of crop. Sub-optimal or excessive growth may result adverse effect on yield attributes. Findings on the, growth parameters of *Ficus carica* such as length and diameter of the shoot, number of leaves, branches and nodes per plant, leaf length and leaf breadth were analyzed and presented below.

4.1.1 Plant height (cm)

Plant height was significantly influenced by different doses of organic and inorganic fertilizers (Appendix II). The variation among the treatments were significant at 5% level of significance at 15, 45 and 105 DAT.

The tallest plant (104 cm) was found (According to R1) in the treatment T_5 (9 kg VC/plant) at 105 DAT. On the other hand, the shortest plant was recorded from (According to R1) the treatment T_1 (80 g N) with the height of 29 cm at 105 DAT. However, at 105 DAT, T_5 was statistically similar to (According to R1) T_9 (12 kg VC + 160 g NF plant^{-1}) (Table 4.1).

Though the tallest plant height was recorded from the plants treated with only VC, but the plants supplied with combined fertilizer (VC + NF fertilizer) from T_6 to T_9, showed a significant growth of plant height than other treatments. Among all the treatments, the treatments where only NF (urea) was given, showed the lowest growth in respect of plant height while even T_0 (control) treatment showed a higher plant height at different DAT (Table 4.1). VC imposed significant effect on plant height as reported by Getnet and Raja (2013). VC and inorganic fertilizer helps plant to grow vigorously. It is because, VC is reservoir of many nutrients and it facilitate plant growth. Though Ertan et al. (2008) reported that with the increment of nitrogenous fertilizer doses, plant height of *Ficus carica* also increases positively from 100g N/ tree to 500g N/ tree treatment range.

Table 4.1: Plant height (cm) of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Plant height (cm) at			
	15 DAT	**45 DAT**	**75 DAT**	**105 DAT**
T_0	18.40ab	23.00bc	44.50	66.83abc
T_1	10.05c	16.75c	24.50	29.00c
T_2	16.17ab	21.17bc	30.33	39.00bc
T_3	15.50b	20.53bc	29.00	30.00c
T_4	14.50bc	19.75bc	42.00	76.50a-c
T_5	21.00a	34.50a	69.00	104.33a
T_6	16.50ab	27.03ab	48.83	67.67a-c
T_7	13.67bc	22.33bc	56.00	81.67ab
T_8	15.33b	22.00bc	58.00	80.33ab
T_9	14.83bc	20.33bc	61.00	98.33a
LSD	4.98	8.29	34.17	49.53

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF/ plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}.

4.1.2 Diameter of shoot (cm)

The diameter of shoot (cm) was significantly influenced by the applied fertilizers. The variation among the treatments was significant at 75 and 105 DAT at 5% and 1% level of significance respectively (Table 4.2).

In general, the highest diameter of shoot (9.33 cm) was recorded in the T_9 (12 kg VC + 160 g NF plant^{-1}) and the lowest (4.65 cm) in T_4 (6 kg VC plant^{-1}) at 105 DAT. It is also mentionable that between T_5 and T_8, there is no significant difference at 105 DAT, though T_8 got 120 g more nitrogenous nutrients (Table 4.2).

Treatments comprising organic fertilizer (VC) either solely or combined with inorganic fertilizer, showed more shoot diameter than plants treated with other fertilizer treatments. The shoot diameter in T_9, T_8 at 105 DAT showed that increasing amount of NF has positive effect on shoot diameter. Our finding is similar with the findings of Ertan et al., (2008). They found that nitrogenous fertilizer has impact on increment of shoot diameter.

Table 4.2: Diameter of shoot (cm) of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Diameter of shoot (cm) at			
	15 DAT	45 DAT	75 DAT	105 DAT
T_0	4.10	4.33	4.67bc	5.67bcd
T_1	3.05	3.50	5.00bc	5.25cd
T_2	4.27	4.60	5.23bc	5.33cd
T_3	4.23	4.43	4.65bc	4.65d
T_4	4.10	4.25	4.58c	5.33cd
T_5	4.90	5.40	6.33ab	8.00ab
T_6	4.33	4.95	5.75bc	7.15abc
T_7	4.93	5.40	6.17abc	6.83bcd
T_8	4.27	4.77	5.60bc	8.00ab
T_9	4.73	5.90	7.77a	9.33a
LSD	1.56	1.42	1.68	2.34

Note: Treatments mean which represent same letter are statistically similar ($p \leq 0.05$).

T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF/plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}.

4.1.3 Number of leaves

Leaf number of *Ficus carica* was significantly affected by the application of different doses of NF and VC. At 15 and 45 DAT, there was significant difference at 1% level of significance and at 75 and 105 DAT, the level of significance was at 0.1% level.

In general, the highest number of leaves was recorded in T_8 (9 kg VC + 120 g NF plant^{-1}) and T_9 (12 kg VC + 160 g NF plant^{-1}) at 105 DAT with 93 and 92.33 leaves respectively at 105 DAT. The lowest number of leaves was recorded in T_1 (80 g NF plant^{-1}) and T_3 (160 g NF plant^{-1}) with 22.67 and 15 leaves respectively at 105 DAT. However, treatments with VC either solely or in combination with inorganic fertilizer produced more leaves than rest of the treatments (Table 4.3).

Table 4.3: Number of leaves of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Number of leaves			
	15 DAT	45 DAT	75 DAT	105 DAT
T_0	13.67b-d	15.67cd	33.33d	52.00bc
T_1	9.00e	13.00d	18.00e	22.67d
T_2	13.00b-e	17.00b-d	15.33e	34.33cd
T_3	9.33e	13.33cd	13.00e	15.00d
T_4	16.67ab	20.00a-c	38.00cd	60.33b
T_5	15.33a-c	22.67ab	40.67b-d	60.67b
T_6	18.33a	25.67a	45.00bc	72.00ab
T_7	14.00b-d	23.00ab	43.33bc	66.67b
T_8	10.33de	19.33a-d	48.00b	92.33a
T_9	11.67c-e	24.67a	65.67a	93.00a
LSD	4.32	6.68	9.50	25.44

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF plant^{-1}; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}.

There was a positive relation of number of branches and number of leaves per plant. The plant which produced higher number of branches also produced higher number of leaves and lower number of branches with lower number of leaves. The increase in number of leaves in treatment T_8 and T_9 revealed that treatments comprising of combined fertilizer produced maximum number of leaves per plant, which is mainly attributed due to application of VC that enhanced the availability of nutrients mostly NPK and abundance of nitrogen fixing bacteria, which might have improved the fertility, aeration, water holding capacity, mineral uptake and synthesis of growth hormones (Mangel and Kirby, 1996).

4.1.4 Number of branches

There was non-significant level of difference in the number of branches among all the treatments at 15, 45, 75 and 105 DAT.

Table 4.4: Number of branches of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Number of branches			
	15 DAT	45 DAT	75 DAT	105 DAT
T_0	2.00	2.00	2.00	2.00
T_1	2.00	2.00	2.00	2.67
T_2	2.67	2.67	3.00	3.67
T_3	2.33	2.33	2.33	2.33
T_4	3.00	3.00	3.00	3.00
T_5	2.33	2.67	2.67	4.00
T_6	3.33	3.67	3.67	3.67
T_7	3.33	3.33	3.33	4.00
T_8	2.67	2.67	3.33	7.33
T_9	3.33	3.33	5.67	8.67
LSD	NS	NS	NS	NS

Note: T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF/plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}, NS= Non-significant.

At 105 DAT, the highest number of branches (8.67) were found in the treatment T_9 (12 kg VC + 160 g NF plant^{-1}) and the lowest (2) was recorded in T_0 (control). Over the period of time, there was no change in the number of branches in T_0 (control), T_3 (160 g NF/plant) and T_4 (6 kg VC plant^{-1}). Comparing to all the treatments, T_7 (6 kg VC + 80 g NF plant^{-1}) and T_8 (9 kg VC + 120 g NF plant^{-1}) enhanced significant increment of leaf number from DAT 15 to 105 DAT (Table 4.4). Organic materials add carbon into the soil provides substrate for microbial growth and subsequent microbial activity. The turnover resulting from the decomposition of organic materials improves the nutrient cycling and availability to the plants especially, N and P which improved root development and subsequently vegetative growth (Iyamuremye and Dick, 1996). Similar observation was made by Smith et al. (1993) who found that addition of organic residues can increase microbial pool sizes and activity, C and N mineralization rates and enzyme activities, all these affect nutrient recycling.

4.1.5 Number of nodes

There was non-significant level of difference in regard of the node numbers of *Ficus carica* among different treatments at 15, 45 and 75 DAT. Significant difference was observed at 105 DAT among the treatments (Table 4.5).

At 105 DAT, the highest number of nodes (167.33) was recorded in T_9 (12 kg VC + 160 g NF plant^{-1}) followed by T_5 (91.67) and T_7 (87.00). The lowest number of nodes (8.67) was recorded in T_2 (120 g NF plant^{-1}) at 15 DAT (Table 4.5).

There is a positive relationship between plant height and number of nodes. The plant which was tall, also produced more number of nodes and smaller plant produced fewer number of nodes. At the same time, length of internodes also matters. The more the length of the internode, lesser was the number of nodes. Though T_5 showed higher plant height than T_9, but T_9 contained highest number of nodes, as the plants received T_5 treatment bearded longer internodes than T_9. Our study has similarity with the work of Ertan et al. (2008). Their study revealed that average length of internode also varied significantly due to application of different fertilizer doses.

Table 4.5: Number of nodes of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Number of nodes			
	15 DAT	45 DAT	75 DAT	105 DAT
T_0	12.33	16.00	33.00	50.00b
T_1	11.67	19.00	28.67	35.00b
T_2	8.67	11.33	19.67	29.00b
T_3	12.67	13.67	17.33	17.50b
T_4	13.00	17.67	33.00	61.67 b
T_5	16.67	32.33	60.67	91.67ab
T_6	12.00	21.67	40.00	56.00 b
T_7	11.67	16.33	47.00	87.00ab
T_8	10.33	17.33	43.00	74.00 b
T_9	20.00	30.00	98.67	167.33a
LSD	NS	NS	NS	80.58

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF/plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}, NS= Non-significant.

4.1.6 Leaf length and leaf breadth (cm)

In respect of leaf length, there was significant differences ($p \leq 0.05$) among the treatments at 15, 45, 75 and 105 DAT (Table 4.6).

In general, T_5 and T_9 resembled the highest leaf length of 21.33 cm and 21.67 cm respectively at 105 DAT. In contrary, the lowest leaf length (4.83 cm) was recorded in T_3 at 15 DAT (except 105 DAT).

Table 4.6: Leaf length (cm) and breadth (cm) of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Leaf length (cm) at				Leaf breadth (cm) at			
	15 DAT	45 DAT	75 DAT	105 DAT	15 DAT	45 DAT	75 DAT	105 DAT
T_0	7.13a-d	9.17a-c	12.57a-c	15.83a-c	5.00b	6.88b-d	9.95a-c	11.50
T_1	6.50a-d	7.90bc	9.40c	13.00c	5.02b	6.22d	7.65c	12.50
T_2	5.30cd	6.33c	8.50c	14.00bc	4.35b	4.96d	6.92c	10.94
T_3	4.83d	5.87c	8.90c	11.50c	4.86b	6.06d	6.59c	9.34
T_4	6.47b-d	8.20bc	10.03c	13.60c	4.27b	5.89d	12.04ab	11.34
T_5	8.50ab	10.67ab	16.07a	21.67a	7.94a	9.60a	8.34bc	16.83
T_6	6.73a-d	10.13ab	11.00bc	15.67a-c	4.27b	5.89d	12.04ab	11.34
T_7	8.90a	11.70a	15.90a	20.67ab	5.23b	8.66a-c	13.51a	15.11
T_8	7.53a-c	10.13ab	12.70a-c	16.67a-c	4.79b	9.39a	10.57a-c	13.55
T_9	8.17ab	12.20a	15.23ab	21.33a	5.17b	8.93ab	12.95a	16.00
LSD	2.42	3.39	4.83	6.82	1.82	2.43	4.05	NS

Note: Treatments mean which represent same letter are statistically similar ($p \leq 0.05$).

T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF plant^{-1}; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}, NS= Non-significant.

The significant differences in leaf breadth at different DAT were observed in every treatment. The lowest leaf breadth was recorded in T_3 (9.34 cm) and the highest has been recorded in T_5 (16.83 cm) and T_9 (16 cm) at 105 DAT (Table 4.6).

The effect of organic manures on growth and yield were reported by Rao and Sankar (2001). According to them, the effects of manures on leaf numbers, leaf area index, dry matter production and other growth factors were significantly better in those where organic and inorganic fertilizers were used.

Leaf length of the T_5 and T_9 treated plants were highest (statistically similar). So, it can be mentioned that the factor which caused higher leaf length might be responsible for higher leaf breadth. Haliru et al. (2014) also noticed similar findings in sweet potato.

4.2 Yield contributing parameters

Yield parameters of *Ficus carica* such as number of fruiting shoot, fruits per plant (kg) and yield per plant (t ha^{-1}) were analyzed for T_o, T_5, T_6, T_7, T_8 and T_9 and presented below.

4.2.1 Number of fruiting shoot

There was non-significant level of difference in the number of fruiting shoot among all the treatments at 15, 45, 75 and 105 DAT (Table 4.7).

The highest number of fruiting shoot (3.67) was recorded in T_9 followed by T_7 (2.67) number of fruiting shoot at 105 DAT. Among all the treatments T_1 (80 g NF $plant^{-1}$), T_2 (120 g NF $plant^{-1}$) and T_3 (160 g NF $plant^{-1}$) and T_4 (6 kg VC $plant^{-1}$) were found with no fruiting shoot. Compared to all of the treatments, the treatments comprising VC and combined fertilizer (T_5, T_6, T_7, T_8 and T_9) reported more number of fruiting shoot than those treated with only NF (T_1, T_2, T_3). On the other hand, T_o (control) maintained same number of fruiting shoot (1.33) from 45 DAT to 105 DAT while there was always seen an increase in the number of fruiting shoot in rest of the treatments (Table 4.7).

From Table 4.8, it can be seen that T_1, T_2, T_3 and T_4 showed no fruiting. The possible reason behind this might be the effect of NF has a negative impact (T_1, T_2, T_3) on fruiting and the buds developed into vegetative shoot rather than fruit. In case of T_4, the amount of VC which was used (6kg $plant^{-1}$) showed poor fruiting result which might be due to the incapability of applied amount of VC to enhance the reproductive growth or compost mineralization might get hampered.

Arancon et al. (2008) reported that vermicompost can improve the physical structure of potting medium and thus increases the populations of beneficial micro-organisms and most probably the availability of the plant growth-influencing-substances such as hormones and humates produced by microorganisms during probably contributed to the increased growth and flowering of petunia.

Table 4.7: Number of fruiting shoot of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Number of fruiting shoot			
	15 DAT	45 DAT	75 DAT	105 DAT
T_0	0.00	1.33	1.33	1.33
T_1	0.00	0.00	0.00	0.00
T_2	0.00	0.00	0.00	0.00
T_3	0.00	0.00	0.00	0.00
T_4	0.00	0.00	0.00	0.00
T_5	0.00	0.00	1.67	1.67
T_6	1.67	1.67	1.67	1.67
T_7	0.00	1.67	2.67	2.67
T_8	0.00	1.67	1.67	1.67
T_9	0.00	1.00	3.67	3.67
LSD	NS	NS	NS	NS

Note: T_0 = Control; T_1 = 80 g NF plant^{-1}; T_2 = 120 g NF V plant^{-1}; T_3 = 160 g NF plant^{-1}; T_4 = 6 kg VC plant^{-1}; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80g NF plant^{-1}; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}, NS= Non-significant.

Table 4.8: Fruiting status of *Ficus carica* as influenced by NF, VC and their combinations

Treatments	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Fruiting status	+	-	-	-	++	++	++	+++	++	++++

Here, (+) = base amount of fruiting; (++) = good amount of fruiting; (+++) = high amount of fruiting; (++++) = profuse fruiting; (-) = no fruiting.

4.2.2 Number of fruits per plant

Total number of fruits per plant varied significantly ($p \leq 0.01$) among the treatments of this study (Table 4.9).

Treatment T_8 and T_5 gave the highest number of fruits (38.50 and 39 respectively). On the other hand, the lowest number of fruits (9.33) was recorded in the treatment T_7. However, it is mentionable that, number of fruits from T_7 is statistically similar with the treatment T_o (13.33) and T_6 (16.00) (Table 4.9).

It can be inferred that the treatment combination T_8 and T_5 proved significantly better as overall treatments, which may be due to the presence of nitrogen fixing bacteria. Further, the increase in the plant height and number of branches per plant as a consequence of improved root environment and increased availability and uptake of nutrients resulted in the increase of total number of fruits per plant. Similar results have been reported by Naidu et al. (2002) and Anburani et al. (2003) in brinjal.

4.2.3 Yield of fruit (kg plant^{-1} and t ha^{-1})

The fruit yield (kg plant^{-1} and t ha^{-1}) was significantly ($p \leq 0.01$) influenced by various treatments of fertilizers (Table 4.9). The range of fruit yield was 0.30 kg/plant (0.75 t ha^{-1}) to 1.43 kg/plant (3.58 t ha^{-1}) from the plants received T_7 and T_8 treatment respectively. Among the treatments, next to T_8, the T_5 (1.24 kg plant^{-1} and 3.1 t ha^{-1}) and T_9 (1.21 kg plant^{-1} and 3.03 t ha^{-1}) treated plants gave considerably good yield.

On the other hand, T_o (control) treated plants also yielded the minimum (0.38 kg plant^{-1}) which is statistically similar to the yield for T_7 treated plants (Table 4.9).

Higher leaf length and leaf breadth increased the photosynthetic surface and thus higher photosynthete accumulations, resulting in higher yield of fruits per plant and fruit weight. The results are in accordance with Shashidhara (2000). Kurubar et al. (2017) also found that treatments consisting of organic fertilizers performed well, but superior characters were found when both organic and inorganic fertilizers were applied together.

Table 4.9: Yield attributing parameters of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Number of fruits per plant	Yield per plant (kg)	Yield per hectare (tha^{-1})	Benefit cost ratio
T_0	13.33c	0.38c	0.92d	1.24d
T_5	39.00a	1.24ab	3.1b	2.94ab
T_6	16.00c	1.03b	2.58c	2.24c
T_7	9.33c	0.30c	0.75d	0.07e
T_8	38.50a	1.43a	3.58a	3.14a
T_9	29.67b	1.21ab	3.03b	2.47bc
LSD	7.5225	0.3314	0.333	0.5839

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_5 = 9 kg VC $plant^{-1}$; T_6 = 12 kg VC $plant^{-1}$; T_7 = 6 kg VC + 80 g NF/plant; T_8 = 9 kg VC + 120 g NF $plant^{-1}$; T_9 = 12 kg VC + 160 g NF $plant^{-1}$.

4.3 Fruit parameters

Fruit parameters such as days required for bud initiation, days required for maturity, diameter of fruit (cm), length of fruit (cm), weight of fruit (g) were analyzed for T_o, T_5, T_6, T_7, T_8 and T_9. Other treatments gave either no fruit or the bud converted into vegetative shoot. The analyzed results have been presented below-

4.3.1 Days required for bud initiation

Days required for bud initiation has been highly influenced by NF and VC. Significantly minimum period (40.50 days) was required in the treatment T_0 (control), T_8 and T_9 followed by T_5 (48.50 days). On the other hand, the maximum period (62.67 days) was required by the plants treated with T_7 (Table 4.10).

The earliness in bud initiation might be due to the enhancement of vegetative growth and storing sufficient reserved food materials from the applied fertilizer containing both VC and NF. However, the plants received no fertilizer also showed similar result. On the other hand, the plants received only NF showed no initiation of fruiting buds and it was delayed in the plants received moderate level of VC and NF. Naik (2005) also recorded delayed flowering in the plants treated with 100% nitrogen through urea.

4.3.2 Days required for maturity of the fruit

Days required for maturity of the fruit has also been significantly ($p \leq 0.01$) influenced by the application of fertilizers. The minimum period (73 days) was required in the treatment T_5 followed by T_6 (79 days). On the other hand, the maximum period (89 and 88.50 days) was recorded by T_7 and T_8 (Table 4.10). However, required days for maturity in T_0 (control) is statistically similar with the fruits from T_7 and T_8 treatments. The observation showed that application of nitrogen has impact on fruit maturity. Plants treated with NF showed delayed maturity than the untreated ones. Naik (2005) also reported the similar findings.

Table 4.10: Days required for bud initiation and days required for maturity of *Ficus carica* as influenced by NF, VC and their combinations

Treatments	Days required for bud initiation	Days required for maturity
T_0	40.50c	87.00ab
T_5	48.50bc	73.00d
T_6	56.00ab	79.00c
T_7	62.67a	89.00a
T_8	40.50c	88.50a
T_9	41.00c	82.00bc
LSD	10.819	5.2544

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80 g NF/plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}.

4.3.3: Diameter and length of fruit (mm)

Diameter and length of fruits varied significantly ($p \leq 0.01$) among the treatments of NF and VC (Table 4.11). The minimum diameter of fruit (36.81 mm and 37.27 mm) were recorded in the treatment T_5 and T_6 respectively, though both the treatments are statistically similar. On the other hand, the maximum diameter of fruit (47.16 mm) was observed in T_9 followed by T_o (43.69 mm). However, T_o (control) is statistically similar with T_7 (6 kg VC + 80 g NF plant^{-1}) and T_8 (9 kg VC + 120 g NF plant^{-1}) (Table 4.11).

The minimum length of fruit (41.44 mm) was recorded in the treatment T_o (control) and it was maximum (59.66 mm) in T_9 followed by T_8 (55.63 mm) (Table 4.11). Plants treated with VC (organic fertilizer) gave highest diameter and length of fruits. Similar result has been reported by Osman and Abd El-Rhman (2010).

Table 4.11: Diameter of fruit, length of fruit and weight of fruit of *Ficus carica* at different DAT as influenced by NF, VC and their combinations

Treatments	Diameter of fruit (mm)	Length of fruit (mm)	Weight of fruit (g)
T_0	43.69b	41.44e	28.60e
T_5	37.27c	49.51d	31.65d
T_6	36.81c	48.68d	34.55c
T_7	41.97b	52.59c	32.35cd
T_8	42.00b	55.63b	37.34b
T_9	47.16a	59.66a	40.89a
LSD	2.2608	1.7965	2.3655

Note: Treatments mean which represent same letter are statistically similar.

T_0 = Control; T_5 = 9 kg VC plant^{-1}; T_6 = 12 kg VC plant^{-1}; T_7 = 6 kg VC + 80 g NF/plant; T_8 = 9 kg VC + 120 g NF plant^{-1}; T_9 = 12 kg VC + 160 g NF plant^{-1}.

The highest number of leaves was recorded in T_8 and T_9 at 105 DAT with 93 and 92.33 leaves. The number of leaves was lowest when only nitrogenous fertilizer was used in T_1 and T_3 treatments (9 and 9.33 leaves respectively.

The number of branches and nodes were highest (8.67 and 7.33 respectively) with the treatment T_9 and the lowest (2) was recorded in T_0.

T_5 and T_9 resulted in bigger sized leaves (leaf length 21.33 cm and 21.67 cm, leaf breadth 16.83 cm and 16 cm respectively) while the small leaves were in the plants receiving T_3 treatment (length 4.83 cm and leaf breadth 4.86 cm).

In regard of fruit parameters, following parameters were taken and analyzed. The results are as follows.

Number of fruiting shoot was maximum (3.67) in T_9 followed by T_7 (2.67). However, no fruiting shoot was observed when only nitrogenous fertilizer was applied in T_1, T_2 and T_3 treatments.

The results showed that T_8 and T_5 gave the highest number of fruits (38.50 and 39) respectively. The lowest number of fruit was (9.33) in the plants treated with T_7. Similarly, the fruit yield was highest in T_8 produced the highest fruit yield (1.43 kg/plant and 3.38 t ha^{-1}) and lowest in T_7 (0.30 kg/plant and 0.75 t ha^{-1}) fruit yield.

For bud initiation, only 40.50 days was required in the treatment T_0, T_8 and T_9 followed by T_5 (48.50 days). On the other hand, the longest period (62.67 days) was required by T_7. After bud initiation, the shortest time was recorded in T_5 (73 days) and longest time was recorded in T_7 and T_8 (89 and 88.50 days respectively) for maturation of fruits.

The maximum diameter and length of fruit (47.16 mm and 59.66 mm respectively) was observed in T_9. In the treatment T_0, fruit diameter and length was minimum (43.69 mm and 41.44 mm respectively).

The minimum weight of fruit (28.60 g) was also recorded in the treatment T_0 and it was maximum (40.89 g) in the fruits from T_9 treated plants.

However, the calculation of BCR showed that T_8 (3.14) provide the highest return followed by T_5 (2.94) while the lowest (0.07) was calculated in T_7.

5.2 Conclusion and recommendation

On the perspective of the findings from the current study, it could be concluded that there is significant effect of nitrogenous fertilizer and vermicompost on growth and yield of *Ficus carica*. For efficient production of *Ficus carica,* vermicompost is very efficient and when it is combined with nitrogenous fertilizer, it gives better yield though plants solely treated with 9 kg vermicompost also performed well. Among the treatments, T_8 resulted as the best combination for the production of *Ficus carica*. It is also clear that *Ficus carica* can produce fruits and is able to give yield even without any kind of fertilizer application. However, the present research work was carried out at field laboratory, Agrotechnology discipline, Khulna University, Khulna in one season only. Further trial in different locations of Bangladesh is needed before final recommendation at farmer's level.

CHAPTER-6

REFERENCES

REFERENCES

Agbede, T.M., Ojeniyi, S.O. and Adeyemo, A.J., 2008. Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in Southwest, Nigeria. American Eurassian Journal of Sustainable Agriculture. 2: 72-77.

Aksoy, U., 2001. Ecological farming. II. In Proceedings of the Ecological Farming Symposium, Antalya, Turkey, 14–16 December 2001.

Ara, R., Khan, S.A.K.U.K, Islam, M.M., 2020. Farmer's perception on fig (*Ficus carica*) cultivation in Kolarao and Kaligonj upazilla of Satkhira. Journal of the Bangladesh Agricultural Extension Society. 32: 27-38.

Arancon. N.Q., Clive A. Edwards, C.A., Babenko, A., Cannon, J., Galvis, P., James D. Metzger, J.D., 2008. Influences of vermicomposts, produced by earthworms and microorganisms from cattle manure, food waste and paper waste, on the germination, growth and flowering of petunias in the greenhouse. Applied Soil Ecology. 39(1): 91-99.

Badgujar, S. B., Patel, V.V., Bandivdekar, A. H. and Mahajan, R.T., 2014. Pharmaceutical Biology. pp. 1–17.

BALKEP (Balkan Ecology Project), 2016. Dig the Fig - The essential guide to all you need to know about figs - *Ficus carica*. (Available from: www.balkanecologyproject.blogspot.com, Retrieved on 07/06/22).

Baraket, G., Saddoud, O., Chatti, K., Mars, M., Marrakchi, M., Trifi, M., & Salhi-Hannachi, A. (2009). Sequence analysis of the internal transcribed spacers (ITSs) region of the nuclear ribosomal DNA (nrDNA) in fig cultivars (Ficus carica L.). Scientia Horticulturae. 120(1): 34-40.

BBS (Bangladesh Bureau of Statistics). 2015. Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Peoples' Republic of Bangladesh, Dhaka. (Available from: http://www.bbs.gov.bd, Retrieved on 05/06/22).

BIRTAN (Bangladesh Institute of Research and Training on Applied Nutrition). 2013. Average per capita per day food intake in Bangladesh. Bangladesh

Institute of Research and Training on Applied Nutrition, BIRTAN, Dhaka, Bangladesh (Available from: http://www.birtan.gov.bd/, Retrieved on 05/06/22).

Bogatyre, A. N., 2000. What are we to eat or how to live longer? Pishchevaya Promyshlemost. 7: 34-35. (C.F. CAB).

Bokhtiar, S.M. and Sakurai, K., 2005. Effects of organic manure and chemical fertilizer on soil fertility and productivity of plant and ratoon crops of sugarcane. Archives of Agronomy and Soil Science. 51(3): 325-334.

Boquet, D.J., Hutchinson, R.L., Breitenbeck, G.A., 2004. Long-term tillage, cover crop, and nitrogen rate effects on cotton. Yield and fiber properties. Agronomy Journal. 96: 1436-1442.

Borah, P., 2018. 7 health benefits of anjeer (fig): from weight management to boosting heart health (Available from: food.ndtv.com/, Retrieved on 05/05/22).

Brandy, N.C. and Weil, R.R., 2002. The Nature and Properties of Soils (13th edition). Prentice Hall. Upper Saddle River, New Jersey. pp. 543-589.

Chavan, P. J., Syedimiaz, Rudraksha, G. B., Malewar, G. and Baig, M. I., 1997. Effect of various nitrogen levels through FYM and urea on yield, uptake of nutrients and ascorbic acid content in chilli (*Capsicum annum* L.). Journal of the Indian Society of Soil Science. 45: 833-835.

Chowdhury, R., 2004. Effects of chemical fertilizers on the surrounding environment and the alternative to the chemical fertilizers. IES-ENVIS Newsl. 7, 4–5.

Dauda, S. N., Aliyu, L. and Chiezey, U.F., 2005b. Effect of seedling age at transplanting and poultry manure on fruit yield and nutrients of garden egg (S. gilo L.) of varieties. Journal of Tropical Science. 5: 38-41.

Devi, K. B. and Singh, N. I., 2012. Yield response of cabbage (*Brassica oleraceae* var. capitate) cv. Pride India to varying levels of chemical fertilizers and vermicompost. IOSR Journal of Agriculture and Veterinary Science. 1(3): 08-11.

Diaz-Zorita, M., Grove, J.H., Murdock, L. and Herbeck, J., 2004. Effects of crop yields and soil properties in a no-till production system. Agronomy journal. 96: 1651-1659.

Duenas, M., Pérez-Alonso, J. J., Santos-Buelga, C., and Escribano-Bailón, T., 2008. Anthocyanin composition in fig (*Ficus carica* L.). Journal of Food Composition and Analysis. 21(2): 107-115.

Edwards, C.A. and Burrows, I., 1988. The potential of earthworm composts as plant growth media. In: Earthworms in Environmental and Waste Management. pp. 211-220.

Eickhout, B., Bouwman, A.P., Van, Z. H., 2006. The role of nitrogen in world food production and environmental sustainability. Agriculture, Ecosystems and Environment. 116: 4-14.

Ertan, B., Cobanoglu, F., Sahin, B., Belge, A., Konak, R. and Tepecik, M., 2008. Effect of nitrogen rates on yield and fruit quality of Fig (*Ficus carica* L. cv. Sarilop). International meeting on soil fertility land management and agroclimatology. pp: 403-411.

Fang, C. H. and Kvonon, H., 1994. Effect of organic manures on the growth and yield of sweet pepper. British Journal of Mathematical and Statistical Psychology. Agricultural Improvement Station. 42: 1-10.

FAOSTAT (Food and Agriculture Organization Statistical Database). 2017. FAOSTAT Agricultural Data. (Available from: https://www.fao.org., Retrieved on 02/06/22).

FAOSTAT (Food and Agriculture Organization Statistical Database). 2017. FAOSTAT Agricultural Data. (Available from: https://www.fao.org., Retrieved on 27/05/22).

Flora of North America Association, FNA, 2002, http://www.fna.org/FNA.

Franzluebbers, A.J., 2007. Integrated crop-livestock systems in the southeastern USA. Agronomy Journal. 99: 361-372.

Gaur, C.A., 1984. Organic manures and biofertilizers. Review of soil research in India Part-I. (12^{th} Edition). International Congress of Soil Science. New Delhi, India.

Getnet, M. and Raja, N., 2013. Impact of vermi compost on growth and development of cabbage, Brassica oleraceae L. and their sucking pest; *Brevicoryne brassicae* L. (Homeptera: Aphididae). Research Journal of Environment and Earth Sciences. 5(3): 104-112.

Gidnavar, V. S., Shashidhara, G. B. and MAnjunathaiah, H. M., 1992. Soil fertility management in monocrop (cotton) through legumes incorporation. Farming systems. 8: 53-55.

Gomez, K. A. and Gomez, A. A., 1984.Statistical procedures for agricultural research (2^{nd} Edition). Jon Wiley and Sons, New York. p. 680.

Hangarge, D. S., Raut, R. S., Gaikawad, G. K., Adsul, P. B. and Dixit, R. S., 2004. Influence of vermicompost and other organics on fertility and productivity of soil under chilli, spinach cropping system. Soil and crops. 14: 181-186.

https://weatherspark.com/y/111687/Average-Weather-in-Khulna-Bangladesh-Year-Round.

Iyamuremye, F. and Dick, R. P., 1996. Advances in Agronomy (Books). p. 139-185.

Janzen, D. H. (1979). How to be a fig. Annual review of ecology and systematics. 10: 13-51.

Jedidi, N., Hasse, A., Van, C. O. and M'Hiri, A., 2004. Microbial biomass in a soil amended with different types of organic wastes. Waste Manag Res. 22: 93–99.

Khan, M.S., Shil, N.C. and Noor, S., 2008. Integrated nutrient management for sustainable yield of major vegetable crops in Bangladesh. Bangladesh Journal of Agriculture and Environment. 4: 81-94.

Kropisz, A., 1992. Influence of fertilization with compost on yield of vegetables and their content of mineral elements. Annals of Warsaw Agricultural University. 16: 9-13.

Kurubar, A.R., Allolli, T.B., Naik, M.K. and Angadi, S.G., 2017. Effect of organic and inorganic fertilizers on fruit characters, quality and economics of fig production (*Ficus carica* L.). Acta Horticulturae. 1173: 213-21.

Lewin, J., 2017. The health benefits of figs. (Available from: www.bbcgoodfood.com, Retrieved on 05/06/22).

Lokappa, D. G., Patil, S. S., Hiremath, G. M., & Jaiprakash Narayan, R. P., 2018. Financial Feasibility of Fig Cultivation (*Ficus carica* Linn.) in North-Eastern Karnataka, India.

Lokappa, D. G., Patil, S. S., Hiremath, G. M., and Jaiprakash Narayan, R. P., (2018). Financial Feasibility of Fig Cultivation (Ficus carica Linn.) in North-Eastern Karnataka, India. Economic Affairs. 63(2): 347-352.

Malawadi, M. N., 2003. Effect of secondary and micronutrients on yield and quality of chilli (*Capsicum annum* L.) (Doctoral dissertation, University of Agricultural Sciences).

Mangel, K. and Kirby, E., 1996. Principles of Plant Nutrition. (4th Editions). Pannma Publishing Corporation, New Delhi, India. 3: 548-569.

Mars, M., 2001. Fig (*Ficus carica* L.) genetic resources and breeding. In II International Symposium on Fig 605. pp. 19-27.

Marwat, S.K., Khan, M.A., Khan, M.A., Rehman, F.U., Akbari, A.H., Ahmad, M., Zafar, M. and Ahmad, F., 2011. Medicinal and pharmacological potentiality of the plant At-Tin-common fig (*Ficus carica* L.). Asian Journal of Chemistry. 23(1): 1-10.

Marwat, S.K., Khan, M.A., Khan, M.A., Rehman, F.U., Akbari, A.H., Ahmad, M., Zafar, M. and Ahmad, F., 2011. Medicinal and pharmacological potentiality of the plant At-Tin-common fig (*Ficus carica* L.). Asian Journal of Chemistry. 23(1): 1-10. (Available from: www.asianjournalofchemistry.co.in, Retrieved on 03/06/22).

Mawa, S., Husain, K. and Jantan, I., 2013. *Ficus carica* L. (Moraceae): Phytochemistry, traditional uses and biological activities. Evidence-Based Complementary and Alternative Medicine. 2013: 1-8. (DOI: 10.1155/201).

Megawer, M. A., 2009. Reducing the amount of inorganic N fertilizers in superior grapevineyard by using organic and biofertilizers and humic acid. Egyptian Journal of Agricultural Research. 87(1): 317-344.

Mehraj, H., Sikder, R. K., Haider, M. N., Hussain, M. S. and Uddin, A. F. M. J., 2013. Fig (*Ficus carica* L.): A New Fruit Crop in Bangladesh. International Journal of Business, Social and Scientific Research. 01(01): 01-05.

Mehraj, H., Sikder, R.K., Haider, M.N., Hussain, M.S. and Uddin, A.F.M.J., 2013. Fig (*Ficus carica* L.): A new fruit crop in Bangladesh. International Journal of Business, Social and Scientific Research. 01(01): 01-05.

Mengel, K. and Kirkby, E. A., 1987. Principles of Plant Nutrition. 4th edition. International Potash Institute. Pem, Switzerland. pp. 687.

Miller, E. W., Donahue, R. L. and Miller, J. U., 1990. Soil "an introduction to Soils and Plant Growth" Brentice Hall International Inc. Engle Word Cliffs, New Jersey. pp. 210-220.

Mullens, B. A., Szijj, C. E. and Hinkle, N. C., 2002. Oviposition and development of *Fannia* spp. Diptera: Muscidae) on poultry manure of low moisture levels. Environmental Entomology. 31: 588-593.

Naidu, A.K., Kushwah, S.S. and Dwivedi, Y.C., 2002. Influence on organic manures, chemical and biofertilizer on growth, yield and economics of brinjal. South Indian Horticulture. 50: 370-376.

Naik, R.K., 2005. Influence of N-substitution levels through organic and inorganic sources on growth, yield and post-harvest quality of Capsicum under protected condition. Unpublished Ph.D. thesis. University of Agriculture Science, Dharwad, India.

Osman, S. M. and Abd El-Rhman, I. E., 2010. Effect of organic and bio nfertilization on growth, productivity of fig tree (*Ficus Carica,* L.). Research Journal of Agriculture and Biological Sciences. 6(3): 3195-328.

Oyewole, C.I., Opaluwa, H., Omale, R., 2012. Response of Tomato (*Lycopersicon esculentum*): Growth and yield, to rates of mineral and poultry manure application in the guinea savanna agro-ecological zone in Nigeria. Journal of Biology and Agriculture. 2: 44–56.

Pimentel, D., 1996. Green Revolution and chemical hazards. Science of Total Environment. 188: 86-98.

Rahman, M.M., Sarker, M.A., Hasina, M.A. and Kashem, M.A., 1998. Role of some indigenous substances as organic fertilizers on growth and yield of brinjal plants. Bangladesh Journal of Scientific and Industrial Research. 33(2): 275-281.

Rao, S. and Sarkar, C.R., 2001. Effect of organic manures on growth and yield of brinjal. South Indian Horticulture. 49: 288-291.

Reddy, B.G. and Reddy, M.S., 1999. Effect of integrated nutrient management on soil available micro nutrients in maize-soybean cropping system. Journal of Research ANGRAU. 27: 24-28.

Reis, A., Lopes, C.A., Moretti, C.L., Ribeiro, C.S.C., Carvalho, C.M.M., Franca, F.H., Villas, G.L., Henz, G.P., Silva, H.R., Bianchetti, L.B., Vilela, N.J., Makishima, N., Freitas, R.A., Souza, R. B., Carvalho, S.I.C., Brune, S., Marouelli, W.A., Nascimento, W.M., Pereira, W. and Melo, W.F., 2007. Berinjela ((Solanum melongena). Brasilia: Embrapa Hortalicas. (Available at https://www.cnph.embrapa)

Renuka, B. and Sankar, R. C., 1998. Effect of organic manure on growth and yield of tomato. South Indian Horticulture. 49: 216-217.

Ribeiro, C.S., Bruune, C.S. and Reifchneider, F.J.B., 1998. Cultivo da berinjrla. Brasilia: Embrapa Hortalicas. 23p. (Embrapa Hortalicas. Instrucao Tecnica 15).

Roe, N.E., Stoffella, J. and Greatz, D., 1997. Compost from various municipal solid wastes feed stocks affect vegetable crops. II. Growth, yield and fruit quality. Journal of American Society for Horticultural Science. 122: 433-437.

Ross, S.M., Izaurralde, R.C., Janzen, H.H., Robertson, J.A., 2008. The nitrogen balance of three long-term agroecosystems on a boreal soil in western Canada. Agriculture, Ecosystems and Environment. 127: 241-250.

Sainju, U.M., Allen, B.L., Lenssen, A.W. and Ghimire, R.P., 2017. Root biomass, root/shoot ratio, and soil water content under perennial grasses with different nitrogen rates. Field Crops Research. 210: 183-191.

Sainju, U.M., Singh, B.P., Whitehead, W.F., Wang, S., 2006. Tillage, cover crop, and nitrogen fertilization effect on soil nitrogen and cotton and sorghum yields. European Journal of Agronomy. 25: 372-382.

Sendur, K.S., Natarajan, S. and Thamburaj, S., 1998. Effect of organic and inorganic fertilizer on growth, yield and quality of tomato. South Indian Horticulture. 46: 203-205.

Shashidhara, G.B., 2000. Integrated Nutrient Management in Chilli (Capsicum Annum L.) under Northern Transitional Zone of Karnataka. Ph. D. Thesis, University of Agricultural Science. Dharwad, Karnataka, India.

Shi-wei, Z. and Fu-Zhen, H., 1991. The nitrogen uptake efficiency from 15N labeled chemical fertilizer in the presence of earthworm manure (cast). In: Advances in Management and Conservation of Soil Fauna. pp. 539- 542.

Singh, S.R., 2006. Response of biofertilizers and pesticides on yield and quality of cabbage, raddish, brinjal in vegetable based rotation system. Applied biology. 8: 36-39.

Singh, T.R., Singh, S.S.K., Singh, M.P., and Srivastava, B.K., 2004. Effect of integrated nutrient uptake and yield under okra-pea-tomato cropping system in Mallisol. Indian Journal of Horticulture. 61: 312-314.

Smith, J.L., Papendick, R.I., Bezdicek, D.F. and Lynch, J.M., 1993. Soil Organic matter dynamics and crop residue management: Soil Microbial Ecology. In: Applications in Agricultural and Environmental Management, ed. Blaine M.F. Marcel Decker and J.R., New York. p. 65-94.

Sohrab, A. and Sarwar, J.M., 2001. Production of vermicompost and its use in upland and horticulture crops. Project Report of Rajshahi University. pp. 152-155.

Solaiman, A.R.M., Rabbani, M.G., 2006. Effects of NPKS and cow dung on growth and yield of tomato. Bulletin of the Institute of Tropical Agriculture, Kyushu University. 1: 31–37.

Spedding, T.A., Hamel, C., Mehuys, G.R. and Madramootoo, C. A., 2004. Soil Microbial Dynamics in Maize-growing Soil under Different Tillage and Residue ManagementSystems. Soil Biology and Biochemistry. 36: 499-512.

Sreenivasa, M.N., Nagaraj, M.N., Bhat, S.N., 2010. Beejamruth: A source for beneficial bacteria. Karnataka Journal of Agricultural Sciences. 17: 72–77.

Stover, E., Aradhya, M., Ferguson, L. and Crisosto, C.H., 2007. HortScience. 42: p. 5.

Subbaiah, K., Sundarajan, S. and Rani, P., 1985. Response of tomato and brinjal to varying levels of FYM and micronutrients under fertility status of soil. South Indian Horticulture. 33: 198-205.

Subbiah, K., 1994. Effect of nitrogen, phosphorus and biofertilizers on yield and nutrient uptake in chilliand bellary onion. Madras Agricultural Journal. 81(5): 277-279.

Subramanian, S., Rajeswari, M. and Chitdeswari, T., 2000. Effect of organic fertilizer on soil moisture conservation in rainfed vertisol. Madras Agricultural journal. 88: 345-347.

Sudhakar, G., 2000. Studies on to identify crop wastes/ lowland weed as alternate source to organics to sustain the productivity of rice based system. Tamil Nadu Agricultural University, Coimbatore, India.

Tomati, U., Grappelli, A. and Galli, E., 1987. The presence of growth regulators in earthworm-worked wastes. In: On Earthworms, Proceeding of International Symposium on Earthworms, Selected Symposium and Monograph. pp. 423-435.

Ullah, M., Islam, M., Islam, M., and Haque, T., 2010. Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. Journal of the Bangladesh Agricultural University. 6(2): 271–276.

USDA (United States Department of Agriculture), 2019. (Available from: https://www.fdc.nal.usda.gov, Retrieved on 5/06/22).

Varvel, G.E., Peterson, T.A., 1990. Residual soil nitrogen as affected by continuous cropping, two-year, and four-year crop rotations. Agronomy Journal. 82: 958-962.

Wagner, W. L., Herbst, D. R., & Sohmer, S. H., 1999. Manual of the flowering plants of Hawai'i. University of Hawai'i Press.

Waksman, S.A., 1952. "Soil microbiology" John Wiley and Sons. Inc., New York. Champion and Hall, Limited London. pp. 336.

Wardle, D.A., Yeates, G.W., Nicholsan, K.S., Bonner, K.I. and Watson, R.N., 1999. Response of soil microbial biomass dynamics, activity and plant litter decomposition to agricultural intensification over a seven-year period. Soil Biology and Biochemistry. 31: 1707-1720.

Weather online, 2022. Bangladesh. (Available from: www.weatheronline.co.uk, Retrieved on 5/06/22).

Appendix I: Physical and Chemical characteristics of soil sample before manure and fertilizer application

Name of parameters	Value	Class of fertility
pH	7.5	Mild alkaline
Electric Conductivity (dS/m)	1.7	Non-saline
Organic matter (%)	2.29	Medium
Total nitrogen (%)	0.133	Low
Phosphorus (μg/ g soil)	5.27	Highly low
Potassium (mg/ 100g soil)	0.45	High
Sulphur (μg/ g soil)	62.42	Extremely high
Zinc μg/ g soil	0.98	Medium
Boron (μg/ g soil)	0.88	Extremely high

Source: SRDI office, Daulatpur, Khulna

Appendix II: Composition of vermicompost

N = 1.9 %	P = 2.0 %	K = 0.8 %	C : N = 13.60 %
Mn =500 ppm	Zn = 100 ppm	Cu = 48 ppm	pH = 8.0

Source: Fertilizer Recommendation Guide- 2005, Bangladesh Agricultural Research Council