CHAPTER I

INTRODUCTION

1.1. Background

Sweet corn (*Zea mays* L. *Saccharata Sturt*) is the most essential food crop after rice, sweet potatoes, sorghum and other food crops. Sweet corn is the primary source of carbohydrates after rice. In addition to usage for food, sweet corn plants are also usable as animal feed and raw materials for the feed industry (Tangendjaja and Wina, 2011). In addition to the source of carbohydrates, sweet corn is also an essential source of protein for the needs of the Indonesian people.

The planting area of sweet corn in Indonesia reaches 440 thousand hectares. East Java Province with an area of 116 thousand hectares, is the largest planting area, the second is Central Java Province with an area of 54 thousand hectares and the third is Lampung Province with an area of 36 thousand hectares, while North Sumatra Province is in sixth place with an area of 23.9 thousand hectares (Ministry of Agriculture, 2018). Based on data from the Ministry of Agriculture, every year sweet corn production always increases. In 2018, national sweet corn production rose 3.91% to 30 million tons compared to 2017, which was 28.9 million tons. Meanwhile, the volume of sweet corn imports to Indonesia since 2016 has been around 1 million tons. In that year, sweet corn imports recorded the most significant decline, namely 65.12% to 1.1 million tons compared to 2015, which reached 3.2 million tons. However, in 2018, sweet corn imports to

Indonesia increased 42.46% to 737.2 thousand tons from 517.5 thousand tons in 2017 (BPS, 2019). Meanwhile, the most significant national consumption of corn is for raw materials in the food industry at 11.1 million tons, for 5.93 million tons in food industry raw materials and for 4.2 million tons in livestock raw materials. Meanwhile, household consumption is 405 thousand tons, while the other is around 1.5 million tons (Databooks, 2019).

Sweet corn production is currently insufficient for domestic needs. When viewed from the 2019 BPS data, Indonesia imports sweet corn every year. This problem is quite essential to study considering the corn is a food commodity in Indonesia. Most of the problems that often occur in sweet corn productivity are that the high nutrient needs of corn have not been fulfilled optimally. Even though the field farmers have given high doses of fertilizer, it, of course, results in damage to soil fertility, waste of fertilizer use and also environmental pollution. As a result, so far, sweet corn production has not yet reached maximum productivity (Lidar and Surtinah, 2012).

According to Hanafiah (2015), agricultural land in Indonesia, in general, still has low levels of soil organic matter, which is around 3-5%. Therefore, it is necessary to add organic matter to meet the nutrient needs of plants. One of the suitable organic materials to improve soil structure is corn waste compost. So far, corn waste has been underutilized or the use of corn cobs is still limited. The waste has a sufficiently high potential, which is more than 70 percent of the total plant biomass and the waste has not been widely used. Corn plantation waste generally not returns to the land or is burned because it interferes with the management of the next cropping land. Actually, corn plant waste can be used as raw material for the manufacture of organic fertilizer as a soil enhancer because corn waste contains cellulose, hemicellulose, and lignin as the primary constituent of plant litter (Herdiyantoro, 2010). Corn waste that is processed into compost is attempted to return organic matter into the soil, which will affect soil fertility, resulting in the increased crop production. Therefore, long-term benefits are obtainable to preserve soil fertility and increase agricultural production (A. Haitami and Wahyudi, 2019).

Based on the results of an analysis conducted at the Central Plantations Service Laboratory (2017), the nutrient content of corn straw compost fertilizer includes pH (H_2O) 5.45, N 0.90%, P 1.32%, K 1.25%, Mg 0.29%, Ca 2.39%, Water Content 23.1%. Corn crop waste can reach 5-6 tons of dry matter (Directorate of Ruminant Livestock Cultivation, 2006). In 2018, corn waste, when viewed from corn production of 30 million tons with waste of 70% of the total biomass of corn plants (Herdiyantoro, 2010), total corn waste is 70 million tons. This makes the use of corn waste into compost will be able to reduce unused waste from corn plants. In addition to the use of organic matter to increase nutrients in the soil, it can also utilize microorganisms that are able to make symbiosis with plants to increase plant growth. One of the microorganisms that can be useful to increase growth is mycorrhizal fungi.

Mycorrhizae are able to streamline the use of chemical fertilizers. The application of chemical fertilizers and the application of mycorrhizae to sweet corn plants by reducing the concentration of 50% of the recommended chemical fertilizers can provide higher productivity than productivity that only provides chemical fertilizers without mycorrhizae. The addition of mycorrhizae to plant cultivation can provide high benefits. Utilization of mycorrhizae can significantly contribute to increasing plant resistance to soil-borne pathogens and phytoplans (Indriani, 2004), able to increase nutrient absorption, stimulate growth (Smith and Read, 2008), increase phosphate absorption, increase other nutritional elements such as N, K and Mg, which is mobile (Setiadi, 1998).

Mycorrhizal fungi can make symbiotics with plant roots and play an essential role in plant growth. Mycorrhizae live around plant roots that are able to increase host plant resistance to drought conditions by modifying soil and plant relationships and increasing water absorption capacity and effective water use, as well as being able to stabilize soil aggregates and soil structure and play a role in increasing nutrient uptake, especially phosphorus (P). and other nutrients, such as N, K, Zn, organic C, S and Mo from the soil (Fuady, 2013). The use of mycorrhizae is able to increase plant production in unfavorable environments and improve soil aggregates, increase the growth of soil microbes that are beneficial for the growth of host plants and as plant protectors from root pathogen infections (Muhammad Imam et al. 2014).

Based on the description above, the author is interested in conducting a study on the growth response and production of sweet corn (*zea mays saccharata* sturt) applying corn waste compost and mycorrhizae.

1.2. Question

In this study, questions are as follows:

1) Will the application of corn waste compost affect the growth and production of sweet corn (*Zea mays saccharata* Sturt)?
2) Will mycorrhizal application affect the growth and production of sweet corn (*Zea mays saccharata* Sturt)?
3) Which dose treatment is most suitable for the growth and production of sweet corn?

1.3. Objective

The objectives of this study are:

1) To determine the effect of corn waste compost application on the growth and production of sweet corn (*Zea mays saccharata* Sturt);
2) To determine the effect of mycorrhizal application on the growth and production of sweet corn (*Zea mays saccharata* Sturt);
3) To determine the appropriate application dose for composting corn waste and the most appropriate dose of mycorrhizal for the growth and production of sweet corn (*Zea mays saccharata* Sturt);

4) To identify the interaction between mycorrhizae and corn compost in sweet corn production

1.4. Hypothesises

1) Corn waste compost significantly increases the growth and production of sweet corn (*Zea mays saccharata* sturt).
2) Mycorrhizae significantly increase the growth and production of sweet corn (*Zea mays saccharata* sturt).
3) Corn waste compost and mycorrhizae significantly increase the growth and production of sweet corn (*Zea mays saccharata* sturt).

1.5. Benefits

1) As one of the requirements to obtain a Bachelor's degree at the Faculty of Agriculture, University of Medan Area
2) As information to those in need about the effect of application of corn waste compost and mycorrhizae on the growth and production of sweet corn plants

CHAPTER II

LITERATURE REVIEW

2.1. The Economic Value of Sweet Corn Plant

Food needs always follow the population and these are influenced by increases in per capita income and changes in people's consumption patterns. It indicates that food diversification is necessary to support the establishment of food self-sufficiency. From this condition, two things must be fulfilled, namely the provision of food and diversification of food processing.

Based on data from the Ministry of Agriculture, every year, sweet corn production always increases. In 2018, national corn production rose from 3.91% to 30 million tons compared to 2017, which was 28.9 million tons. Meanwhile, the volume of sweet corn imports to Indonesia since 2016 has been around 1 million tons. In that year, sweet corn imports recorded the most significant decline, namely from 65.12% to 1.1 million tons compared to 2015, which reached 3.2 million tons. However, in 2018, sweet corn imports to Indonesia increased from 42.46% to 737.2 thousand tons, from 517.5 thousand tons in 2017 (BPS, 2019). In each hectare, corn plant waste can reach 5-6 tons of dry matter (Directorate of Ruminant Livestock Cultivation, 2006). Corn waste, in 2018, when viewed from corn production of 30 million tons with a waste of 70% of the total biomass of corn plants (Herdiyantoro, 2010), the total corn waste is 70 million tons.

The role of the agroindustry to advance food is very much necessary. Agroindustry is an agriculture-based industry aiming at being able to provide value-added from commodity that converts into a value-added product. Agroindustry with raw materials for sweet corn is now widely circulating, such as corn oil, corn syrup and corn sugar, which have many advantages. Thus, it is increasingly evident that food made of sweet corn is no longer an 'inferior' food at this time. Even with the increasingly good slogan indicating that food of corn can reduce blood sugar and non-cholesterol levels, many people search and consume the product increasingly.

In addition to obtaining food and feed, corn is also widely usable in the food, beverage, chemical, and pharmaceutical industries. Based on the chemical composition and nutritional content, corn has prospects as food and industrial raw materials. The utilization of corn as an industrial raw material will provide value-added for the farming of these commodities, especially for farmers, most of whom still sell corn in the form of commodities.

The protein content of corn is higher than rice, so it is suitable for nutritious food ingredients. The results of the analysis conducted by Balitjas showed that the protein contents of 100 g of corn flour, sorghum and wheat flour were 9.2 g, 11.0 g and 11.5 g, respectively, which was higher than rice flour only containing 7.0 g of protein (Suarni, 2002).

Sweet corn kernels are rich in carbohydrates. Most are in the *endospermium*. Carbohydrate content can reach 80% of the entire dry matter of seeds. Carbohydrates in the form of starch are generally a mixture of amylose and amylopectin. In glutinous corn, most or all of the starch is amylopectin. This difference does not have much effect on the nutritional content, but it is more significant in processing food. Sweet corn is found containing lower amylopectin but having an increase in phytoglycogen and sucrose. Table 1 and Table 2 show the contents of substances in yellow and sweet corn, respectively.

Table 1. Content of Components in 100 g of New Harvest Yellow Corn

Component	Content	Component	Content
Water (g)	24	P (mg)	148
Calorie (kal)	307	Fe (mg)	2.1
Protein (g)	7.9	Vitamin A (SI)	440
Fat (g)	3.4	Vitamin B1 (mg)	0.33
Carbohydrate (g)	63.6	Vitamin C (mg)	0
Ca (mg)	9		

Source: (https://www.scribd.com/document/61858594/article-ppm-jag2)

This difference does not have much effect on the nutritional content, but it is more significant in processing food. Sweet corn is not capable of producing starch so that the seeds taste sweeter when they are young. Table 2 shows the contents of sweet corn.

Table 2. Nutritional Content in 100 g of Sweet Corn

Carbohydrate (g)	19
Sugar (g)	3.2
Fiber (g)	2.7
Calorie (kkal)	90

Protein (g)	3.2
Fat (g)	1.2
Vitamin A, equal to 10..g	1 %
Pholate (Vit. B9), 46 ..g	12%
Vitamin C, 7 mg	12%
Ferrous, 0.5 mg	4%
Magnesium, 37 mg	10%
Potassium, 270 mg	6%
Water (g)	24

Source: (https://www.scribd.com/document/61858594/article-ppm-jag2)

Sweet corn contains relatively high sugar content, because it is usually picked young to roast or boil. The characteristic of this type is that, when it is ripe, the seeds become wrinkled and are helpful as food ingredients, animal feed, raw materials for drug fillers and others (Harizamrry, 2007). In addition to usage as food and feed ingredients, currently corn is also usable as an alternative energy source. Moreover, corn starch can convert into polymers as a substitute for the primary function of plastic. One company in Japan has mixed corn polymers and plastics into raw materials for computer cases that are ready to market (Budiman, 2012).

2.2. Classification of Sweet Corn Plants (*Zea mays saccharata* Sturt)

According to Pratama (2015), sweet corn is a plant that belongs to the same family as grasses with the species *Zea mays saccharata* Sturt. This plant has a monoceous and single stem. The life cycle of the sweet corn plant consists of vegetative phase and generative phase and has the following classifications:

Kingdom	: *Plantae*
Division	: *Spermatophyta*
Sub Division	: *Saskatchewan*
Class	: *Monocotyledonae*
Ordo	: *Ginae*
Family	: *Ginae*
Genus	: *Zea*
Species	: *Zea mays saccharata* Sturt

2.3. Organic fertilizer

The definition of organic fertilizer, according to American Plant Food Control Officials (AAPFCO), is a material that contains carbon and one or more nutrients other than H and O, which are essential for plant growth. Meanwhile, according to the USDA National Organic Program, all organic fertilizers that do not contain prohibited ingredients and are deriving from natural ingredients, namely from plants or animals, sewage sludge, and non-organic materials are excluded. According to USEPA, organic fertilizer is manure or compost that is applicable to plants as a source of nutrients (Funk 2014).

The various definitions above, in essence, indicate that organic fertilizers contain carbon elements and other nutrients in combination with carbon. Organic fertilizers are fertilizers deriving from dead plants, animal dung, animal parts and other organic wastes gone through the engineering process. In solid or liquid form, these can be enriched with mineral materials and/or beneficial microbes to increase the nutrient content and soil organic matter and improve physical, chemical, and biological properties of soil (Ministry of Agriculture No. 70/Permentan/SR.140/ 10/2011).

2.4. Compost

Compost is an organic fertilizer that decomposes slowly, stimulates soil life and improves soil structure. Compost also has a positive effect on plant resistance to pests and diseases. Compost is also defined as man-made organic fertilizer created from the process of decaying the reprimarys of living things (plants and animals). Compost not only adds nutrients, but also primarytains the function of the soil so that plants can grow well.

Production of commercial compost made of agricultural waste using organic fertilizer activator is a safe choice as a natural soil enhancer than chemical fertilizers (Al Barkah, et al., 2013). Compost made by using composting activators such as bacteria and fungi with their enzymes is a composting acceleration method that is able to produce good quality compost in a short time of fewer than 35 days (Sadik, et al., 2010). Compost quality is determined by microbial activity in the composting process and microbial activity is influenced by several factors, namely: raw materials, nutrient composition, humidity, temperature, acidity or salt, and aeration (Anyanwu, et al., 2013).

SNI No. 19-7030-2004 contains the scope, references, terms and definitions, requirements for chemical, physical and bacterial content that must be achievable from processed domestic organic waste into compost, and compost quality characteristics and specifications. Various contained definitions include the definition of compost, decomposition, water content, microelements, foreign materials, organic pollutants, domestic organic waste, C/N ratio, pathogenic organisms, agronomic values and groundwater temperature (SNI 19-7030-2004). The requirements that the compost product must meet in the SNI are (i) compost maturity, (ii) foreign material content, (iii) microelement content, (iv) pathogenic organism content, (v) organic pollutant content, (vi) organic content, (vii) moisture content, and (viii) agronomic value (SNI 19-7030-2004).

2.5. Corn Straw Compost

Many farmers grow sweet corn and they only use its fruit. Some farmers do not use sweet corn litter in the form of stems and leaves. At the same time, sweet corn litter can be processed into compost-producing organic fertilizer. Meanwhile, the most significant national consumption of corn is for raw materials of the food industry at 11.1 million tons, of food industry raw materials for 5.93 million tons and of livestock raw materials for 4.2 million tons. Meanwhile, household consumption is 405 thousand tons, while the other is around 1.5 million tons (Databooks, 2019). In each hectare, corn crop waste can reach 5-6 tons of dry matter (Directorate of Ruminant Livestock Cultivation, 2006). Total corn waste, in 2018, viewed from corn production of 30 million tons with waste of 70% of the total biomass of corn plants (Herdiyantoro, 2010), is 70 million tons.

Corn litter compost can be used to fertilize land and can be useful as a product that is very profitable for elements of society, especially for the farmers themselves. Corn plants contain 0.92% Nitrogen, 0.29% Phosphorus, and 1.39% Potassium (Ruskandi, 2005). Lack of infrastructure can be an obstacle in processing the abundant corn litter. In the study by Surtinah (2013), the results obtained were compost with corn litter containing 10.5% Carbon, 1.05% Nitrogen, C/N ratio 9.97, Phosphorus 1.01%, Potassium 0.18%, and Calcium 1 .98 me/100 g.

The stem has three primary tissue components, namely the skin (epidermis), vascular bundles (*vascular bundles*), and the center of the stem (*pith*). The vascular bundles are arranged in concentric circles with a high density of bundles, and circles towards the pericarp near the epidermis. The density of the bundles decreases as they approach the center of the stem. The high concentration of vascular bundles under the epidermis makes the stems resistant to fall. The maize genotypes with strong stems had more layers of thick-walled sclerenchyma tissue under the stem epidermis and around the vascular bundles. There are variations in bark thickness between genotypes that can be used for the selection of plant tolerance to stem fall (Nuning, 2011).

After the coleoptile appears above the ground, the corn leaves begin to open. Each leaf consists of leaf blade, ligules, and leaf sheath that tightly attach to the stem. The number of leaves is equal to the number of stems. The number of leaves generally ranges from 10-18 strands. The average appearance of fully open leaves is 3-4 days per leaf. Corn plants in the tropics have relatively more leaves than those in temperate climates (Paliwal 2000). Corn genotypes vary in length, width, thickness, angle, and leaf pigmentation. Leaf width is classifiable from very narrow (< 5 cm), narrow (5.1-7 cm), medium (7.1-9 cm), wide (9.1-11 cm), to very wide (>11 cm) (Nuning, 2011).

The cornhusk is light green when it is young and dries on the tree when it is old serving to protect the corn kernels. So far, cornhusk waste can be usable as animal feed material for 18.1% of the production by the community, but its utilization has not been maximal because it has low economic value and, when burned, it will cause environmental pollution.

Corn plants have one or two cobs, depending on the variety. Corn cobs are covered with *kelobot* leaves. Corn cobs located at the top generally form earlier and are more significant than those located at the bottom. Each cob consists of 10-16 rows of seeds where number is always even (Nuning, 2011).

Corn kernels are called kariopsis, the ovarian wall or pericarp fuses with the seed coat or testa, forming the fruit wall. Corn kernels consist of three primary parts. These are (a) pericarp, having a thin outer layer, functioning to prevent the embryo from nuisance organisms and water loss; (b) endosperm, as a food reserve, reaches 75% of the seed weight containing 90% starch and 10% protein, mineral, oil, and others; and (c) embryo (sprout), as a miniature plant consisting of *plamule*, radical root, *scutellum*, and coleoptile (Nuning, 2011).

Endosperm starch is composed of *anhydroglucose* compound mainly consisting of two molecules, namely *amylose* and *amylopectin*, and a small amount of intermediate. However, some types of corn have variations in the proportion of *amylose* and *amylopectin* content. Corn kernel endosperm protein consists of several fractions, which are classifiable based on their solubility into *albumin* (soluble in water), *globumin* (soluble in saline), *zein* or *prolamin* (soluble in high concentrations of alcohol), and *gluten* (soluble in alkali). In most corns, the proportion of each protein fraction is 3% *albumin*, 3% *globulin*, 60% *prolamin*, and 34% *glutein* (Nuning, 2011).

2.6. Mycorrhizae

Mycorrhizal taxonomy is as follows:

Phylum : *Zygomycota*

Ordo : *Glomeromycota*

Sub Ordo : *Gigasporineae*

Family : *Gigasporaceae*

Genus : *Gigaspora Scutellospora*

As soil microorganisms, mycorrhizal fungi are vital in facilitating the absorption of nutrients by plants (Suharno and Sufati, 2009; Upadhayaya et al., 2010). The role of mycorrhizae is to help the absorption of plant nutrients, increase growth and yield of plant products. Mycorrhizae increase plant growth at low soil fertility levels, degraded land and help expand the function of roots in obtaining nutrients (Garg and Chandel 2010). Figure 1 shows the process of penetration of AMF in plants.

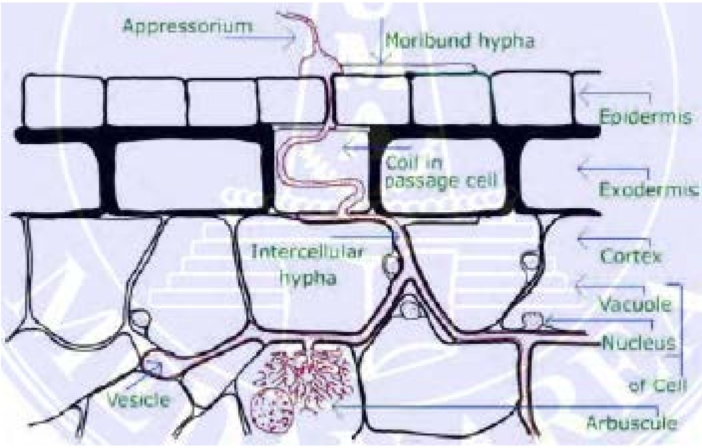

Figure 1. Penetration of AMF in plant cells (Dewi, 2007)

2.7. Benefits of Mycorrhizae

In particular, mycorrhizal fungi play an essential role in increasing the uptake of ions in low mobility, such as phosphate ($PO4^{3-}$) and ammonium ($NH4^{+}$) (Suharno and Santosa 2005) and other relatively immobilized soil nutrients such as sulfur (S), copper (Cu), and Boron (B). Mycorrhizae also increase the surface area in contact with the soil, thereby increasing the root absorption area up to 47 folds. Mycorrhizae do not only increase the rate of nutrient transfer in the roots of the host plant, but also increase resistance to biotic and abiotic stresses (Smith and Read, 2008).

Mycorrhizae are able to help primarytain the stability of plant growth in polluted conditions (Khan, 2005).

Infectivity is defined as the ability of fungi to infect and colonize plant roots. In this case, infectivity is expressed as the proportion of infected plant roots (Nuhamara, 1994). Mycorrhizal infectivity is influenced by fungal species, host plants, microbial interactions, root type of host plants, and competition between mycorrhizal fungi referred to as biotic factors, and soil environmental factors referred to as abiotic factors (Solaiman and Hirata, 1995).

2.8. The Successful Use of Mycorrhizae in Growth and Production of Various Plants

Mycorrhizae have been widely usable to increase crop production. Based on study by Maulana Malik, et al (2017), AMF application was able to increase soybean production on Ultisol soils through the observation variables of number of pods per plant, pod weight per plant, number of seeds per plant, and weight of 20 seeds. Increasing the growth and production of green beans should be treated by mycorrhizae. Giving mycorrhizae at a dose of 10 g/clump consisting of two plant stems combined with 10 tons of animal manure per hectare was able to increase the growth and production of green bean plants, especially in increasing production quality, namely weight of 100 grains, number of pithy pods, and production per clump and production per plot (Prabowo, 2012).

Other studies have also shown that the treatment of *arbucular mycorrhizae* could increase the productivity of green beans at a dose of 15 g/clump (M3) resulting in the best growth and production on all observed variables. The treatment of phosphate dose of 112 kg/ha equivalent to 0.28g/polybag (P3) or a dose of 75% of the recommended dose resulted in the best growth and production on all observed variables. The interaction of mycorrhizal treatment of 15 g/clump in dose of phosphate 112 kg/ha equivalent to 0.28 g/polybag and dose of 75% of the recommended dose (M3P3) resulted in the best plant growth and production on all observed variables (Fitrianto, et al 2014).

Based on study already carried out on the *Kepok* banana plant, the application of indigenous AMF (Glomus type 1 and Acaulospora type 4) deriving from the *rhizosphere* of the Kepok banana plant in endemic areas of bacterial blood disease, Baso Sub-District, Agam District, West Sumatra could induce *Kepok* banana plants against BDB in greenhouse testing (Suswati et al., 2007). Both types of indigenous AMF could also accelerate the fruiting period and increase 25-30% production in endemic lands and could reduce the percentage and intensity of outbreak by 90.8% (Suswati et al., 2011b).

Different application of Glomus isolates (Glomus type-1 and G. fasciculatum)

very significant with the application of Acaulospora type-4 for incubation period parameters, percentage and intensity of attacks. Goods Seeds are applied with 2 types

The *Arbuscular Mycorrhizal* Fungi (AMF) were not attacked by BDB (Blood Disease Bacterium), the application of *Acaulospora* type-4 had a lower percentage of BDB attack at 33.33%. In plants that dud not applied AMF (control), all plants were attacked by BDB (Suswati, 2013). In general, AMF (*Glomus* type-1, *Acauluspora* type-4, *Multispora*) could increase plant growth. The application of AMF of *Glomus* type-1, *Acauluspora* type-4, *Multispora* had a very significant effect on the parameters of plant height, leaf number and wet weight of banana plants and had a significant effect on plant shoot weight parameters and had no significant effect on root wet weight (Suswati, 2018).

Arbuscular mycorrhizal fungi (AMF) (*Glomus* type-1, *Acaulospora* type-4, *Glomus fasciculatum*) were able to increase the growth (height, number of leaves and stoves) of maize and banana seeds observed from the high percentage and intensity of AMF colonization and intensive *mycorrhizal* structures (spores, external hyphae and internal hyphae) (Suswati, 2019). The application of chemical fertilizers Urea, SP.36 and KCl was able to increase plant height growth and production (number of fruits, fruit weight) of mycorrhizal red chili (*Capsicum annum L*) plants (Suswati, 2017). Planting of mycorrhizal, *barangan* banana seedlings can be done by reducing soil-planting media of 25–100%, which is substituted with husk charcoal or coconut husk. The application of AMF and improvement of the composition of the growing media can increase the resistance of *Barangan* bananas to Foc and BDB (Suswati, 2015).

According to Mieke et al., (1999) in Rosliani and Sumarni (2009), the use of *arbuscular mycorrhizae* can increase the uptake of immobile elements, especially P. The results of study indicate that use of *arbucular micorizae* can increase absorption of elements N and P in soybean plant, the efficiency of using P fertilizer is up to 50%, and can also reduce the use of agricultural lime and increase the growth and yield of soybeans, green beans, peanuts, corn and sweet potatoes. Simanungkalit (1999) stated that the use of mycorrhizae could increase the number and weight of potato tubers.

CHAPTER III

MATERIAL AND METHOD

3.1. Time and Location

This study was carried out from March 2020 to June 2020. The location of this study was at Campus 1, University of Medan Area, Jl. Pool No. 1 Medan Estate, Percut Sei Tuan Sub-District. The location of this study was in the experimental garden of the Faculty of Agriculture, University of Medan Area, with an altitude of ± 22 m above sea level, in flat topography.

3.2. Tools And Ingredients

The tools used in the experiment were: hoe, sickle, meter, tarpaulin, plot label, sack, scales, plastic rope, stationery and *gembor*, grass milling machine, microscope, object glass, cover glass, plastic bottle, knife, tweezers , lawn mower, hand sprayer.

The ingredients used in this are: sweet corn seeds of bonanza F1 variety, water, corn waste, mycorrhizae, NPK fertilizer, EM4, brown sugar, decis, 6% Hcl, 3% NaOH, methylene blue, and alcohol, sweet corn plant roots .

3.3. Methods

The experimental design used was a factorial randomized block design (RBD), namely giving corn and mycorrhizal waste compost.

1) Corn waste compost in various doses consists of 5 levels of treatment, namely:

J0 = No corn waste compost (Control)

J1 = Corn waste compost dose of 10 tons ha^{-1} (1080 g/1.08 m^2)

J2 = Corn waste compost dose of 20 tons ha^{-1} (2160 g/1.08 m^2)

J3 = Corn waste compost dose of 30 tons ha^{-1} (3240 g/1.08 m^2)

J4 = Corn waste compost dose of 40 tons ha^{-1} (4320 g/1.08 m^2)

2) Mycorrhizal application consists of 4 levels of treatment, namely:

M0 = No mycorrhizal inoculants (control)

M1 = 5 g/plant mycorrhizal inoculants

M2 = 7.5 g/plant mycorrhizal inoculants

M3 = 10 g/plant mycorrhizal inoculants

Thus, there are 20 treatment combinations where each consisting of:

J0M0	JIM0	J2M0	J3M0	J4M0
J0M1	J1M1	J2M1	J3M1	J4M1
J0M2	J1M2	J2M2	J3M2	J4M2
J0M3	J1M3	J2M3	J3M3	J4M3

Each treatment was repeated twice on the following provisions:

(tc - 1) (r - 1) ≥ 15

(20 - 1) (r - 1) ≥ 15

19 (r - 1) 15

19 - 19r ≥ 15

19r ≥ 15 + 19

19r 34

r 34/19

r ≥1.78

r = 2 repetitions

Where:

Number of Treatments	= 2 treatments
Number of Repeats	= 2 Repetitions
Number of experimental plots	= 40 plots
Number of plants per Plot	= 4 plants
Total Plants	= 160 plants
Plot Size	= 120 x 90 cm
Bed Height	= 30 cm
Number of Sample Plants/plot	= 2 plants
Total Sample Plants	= 80 plants
Distance between plants	= 60 x 30 cm
Distance between plots	= 50 cm
Distance between tests	= 100 cm

3.4. Method of Data Analysis

Linear method was created for factorial Randomized Block Design (RBD). The method of data analysis was useful for knowing the effect of the treatment made, then a list of variances was compiled, and treatments having real and very significant effect were followed by a mean difference test based on the Duncan distance test using the following analysis formula:

$$Y_{ijk} = \mu + pi + \alpha j + \beta k + (\alpha\beta)jk + \sum ijk$$

Where:

Y_{ijk} = Observation results in the first group which received treatment with corn waste compost at grade j and mycorrhizae at grade k

μ = Mean value of treatment

pi = influence of the i-th group

αj = effect of corn waste compost level j

βk = mycorrhizal effect level k

$(\alpha\beta)_{jk}$ = The effect of the combination of corn waste compost at the jth level and mycorrhizal to the level k

Σijk = Effect of error from corn waste compost treatment at level j and mycorrhizal treatment at level k and replication at level i.

3.5. Implementation

3.5.1. Corn Waste Compost Making

Corn waste compost was deriving from fresh material, where the corn plants used were stems, leaves and cobs. Ways to make corn waste compost: The basic ingredients of corn waste as much as 200 kg were chopped using grass grinding machine to the smallest and smoothest part aiming at accelerating the decomposition process, after the corn waste had been chopped into small pieces and had been smooth. The chopped results were placed on a tarpaulin in a size of 5 x 6 m. Then, give 200 ml of EM4 and 200 g of brown sugar dissolved in 5 liters of water and pour into the chopped corn waste. Cover with a tarp all the way through and make sure nothing is open. Every 7 days, open and pour the compost to primarytain air circulation and equalize the temperature between the top layer and the bottom layer of compost. Corn waste compost is ready to use when it meets the compost quality standards, which can be seen from the color that has started to darken, the aroma does not smell bad and the C/N content is 10-15. After the compost has been decomposed for 60 days, an analysis of its nutrient content (N, P, K, C/N, organic C, pH) was carried out at the Central Laboratory of Palm Oil Research (PPKS) Medan.

Figure 2. Composting corn waste

Note: (a) Corn waste collection from Sampali village, Percut Sei Tuan sub-district, (b) Grinding corn waste, (c) Sprinkling corn waste on a tarp, (d) Mixing microorganisms, (e) Watering microorganisms to accelerate composting, (f) Corn waste compost

3.5.2. Preparation for Mycorrhizae

Mycorrhizal inoculants were obtained from the collection of Dr. Ir. Suswati, MP. 1 g of inoculant contains 100-spore density and has mixtures, such as: *Glomus* and *Acaulospora* sp.

3.5.3. Land Cultivation

a. Land Clearing

Land preparation began with clearing the land of growing weeds, plant residues, and the woods in the land using machetes, tripes, forks and hoes, then plowing the area with a hand tracker. Then, make a bed in a size of 120 cm x 90 cm, a bed height of 15 cm in a distance between plots of 50 cm and a distance between replications of 100 cm. In one bed, planting holes are made with a spacing of 60 x 30 cm, so that we get 4 planting holes per bed.

Figure 3. Land preparation

Where: (a) Land clearing, (b) Soil cultivation, (c) bedding

b. Analysis of Soil and Compost

Soil was analyzed before planting and after harvesting. Soil samples were taken compositely from several points on the land to use for maize cultivation. The analysis was for the elements N (Nitrogen), P (phosphorus), K (potassium), Ca (calcium), Mg (magnesium) and pH (degree of acidity) of the soil carried out at the Central Laboratory of Palm Oil Research (PPKS). (See Appendix 5)

c. Application of Corn waste compost

The application of corn waste compost was according to the treatment dose by sowing evenly a week before planting.

Figure 4. Application of corn waste compost to crop plots

Where: (a) Preparation of corn waste compost, (b) Weighing corn waste compost, (c) Application of corn waste compost to beds according to treatment.

d. Planting of Sweet Corn Seed

The planting holes were made in a single way using wood according to the spacing, namely: 60 x 30 cm as deep as 3 cm, then mycorrhizae were inserted into the planting holes along with 2 seeds of sweet corn seeds per planting hole. Then, the planting holes were covered by soil.

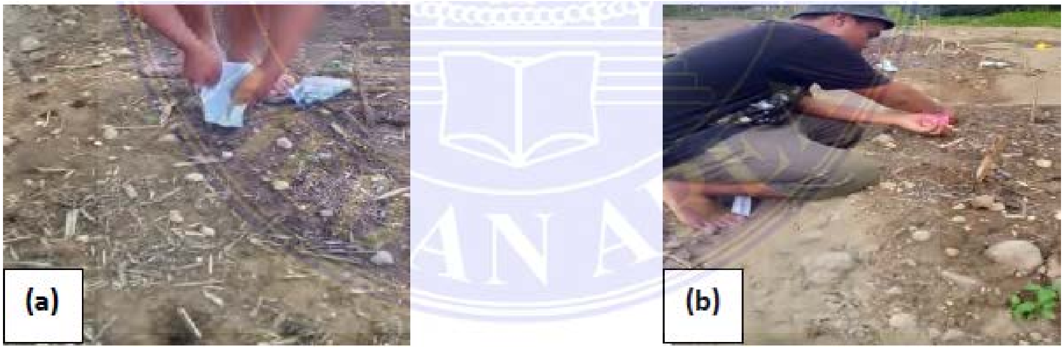

Figure 5. Mycorrhizal application and sweet corn cultivation

Where: (a) mycorrhizal application, (b) planting

3.6. Plant Primarytenance

3.6.1. Watering

Watering was necessary in sweet corn cultivation to primarytain plant water conditions. Watering was carried out 2 times a day, namely in the morning at 07.00 - 08.00 WIB and in the afternoon 17.00 - 18.00 WIB using *gembor* sufficiently. When it rained, watering was not necessary.

3.6.2. Insertion

After planting the seeds, what things to do were checked a week after planting sweet corn plants. This check was carried out to insert plants that did not grow or die and, in this insertion, the dead plants were replaced with new plants of the same age that have been prepared in the insertion plot.

3.6.3. Weeding

Weeding needed to do, which aimed to clear the land of weeds so that there was no competition for nutrients in the growth of the primary plants so that the growth of the primary plants was more optimal. Weeding was done every week and was done manually by using a hoe and pulling.

3.6.4. Fertilizing

Fertilizer was given in accordance with the dose of 50% of the recommendation. Two weeks after planting, fertilization was done by using the recommended fertilizer of 75 kg urea/ha-1 (8.1g/plot), 50 kg SP-36/ha-1 (5.4 g/plot). 50 kg KCl/ha-1 (5.4 g/plot) (BPPTP, 2009) was given evenly by making a run around the plant and then, on day 4 weeks after planting, a dose of 125kg urea/ha-1 (13.5 g/plot) was given evenly by making a run around the plant.

3.6.5. Bumping

Bumping was carried out aiming to increase the soil around the plant that has been eroded by rainwater or at the time of watering and bumping aimed to strengthen the establishment of the plant. Bumping was done simultaneously by weed cleaning done once a week.

3.6.6. Control of Pest and Disease

Essential pests of sweet corn plants are *Spodoptera frugiferda* and *Oxya serville*. Control is done by contact insecticide decis dose according to the recommendations.

Controlling of sweet corn plant diseases can be done by preventing disease from developing in the planting area, namely by means of land sanitation, and making drainage to prevent waterlogging. If the attack has occurred, control is carried out by using pesticides in accordance with the disease that attacks the dose and concentration following the recommendations for use.

3.6.7. Harvesting

Harvesting is done after the plants are 85 days old after planting. Harvesting is done when the tip of the cob of the sweet corn is full. In addition, the color of sweet corn seeds has turned yellow and new harvesting can be done when the sweet corn hair has browned.

3.7. Observation Parameters

3.7.1. Plant Height (cm)

After the sweet corn plant was 2 WAP, plant height was observed until the plant was 7 WAP, with an interval of 1 time a week. Plant height was measured from the soil surface (root neck) to the tip of the highest leaf using a ruler and tape measure.

3.7.2. Number of Leaves

After the sweet corn plant was 2 WAP, the number of leaves was counted on the sample plants that had fully opened. The number of leaves was counted up to 7 WAP with the calculation interval 1 time a week.

3.7.3. Stem Diameter (cm)

The diameters of the stems of corn plants were measured by using a caliper twice in the opposite direction at the base of the stem that had been marked with a height ranging from 15 cm from the ground. The first measurement was carried out starting from plants aged 2 weeks after planting (WAP) with an interval of once a week until 7 WAP.

3.7.4. Flowering Age (days)

The flowering age of corn plants was observed and the plants that had flowered were recorded. Plants observed were sample plants for each treatment plot.

3.7.5. Cob Length (cm)

The length of the cob was measured at the time of harvest. The yield of the sample plants was measured for the length of the cob along with the seeds (without the cob and stalk) starting from the base of the cob to the tip of the cob using a tape measure (ruler).

3.7.6. Sample Crop Production (g)

The plant production of each sample was weighed and calculated using a scale. This weighing aimed to determine the production of sweet corn plants.

3.7.7. Crop Production Per Plot (g)

At the time of harvesting, all crop products per plot were collected and weighed using a scale.

3.7.8. Wet Cob Production per Sample (g)

The process of weighing the products of wet cobs per plant per sample was carried out by weighing corn cobs that had been peeled and cleaned per sample plant when the sweet corn plants were ready to harvest (85 days).

3.7.9. Wet Cob Production per Plot (g)

The process of weighing the products of wet cobs per plot was carried out by weighing the corn cobs that have been peeled and cleaned per plot when the sweet corn plants were ready to harvest (85 days).

3.7.10. Observation of Root Colonization

To be able to see root infection, it is necessary to stain the roots with methylene blue solution. Samples of plant roots from the sampling activity were cut in size of 5 cm as many as 10 pieces at the age of 45 days after planting. The root pieces were washed in the running water until the dirt and adhering soil disappeared. The roots were soaked in 10% KOH solution for ± 24 hours or until the roots look white or clear yellow. The KOH solution was discarded and the roots were rinsed in the running water until clean. The roots were soaked in 3% HCl solution for 24 hours. It was done so that the coloring process that would be carried out could occur ideally (in blue). The Hcl solution was then discarded and the roots were rinsed in the distilled water until clean. Transfer the roots to the methylene blue solution soaked for 24 hours until the roots turn blue.

After the staining was complete, the root samples could be observed for root observations. It was done by cutting the stained roots in 1 cm, then the roots were arranged on the slide and covered with a cover glass, the number of roots per preparation was 5 pieces. After the preparations were ready, then immediately these were observed under a microscope. Root infection could be seen through the presence of vesicular, arbuscular and hyphae infecting the roots. Observation of the colonization process of sweet corn root can be seen in Figure 6.

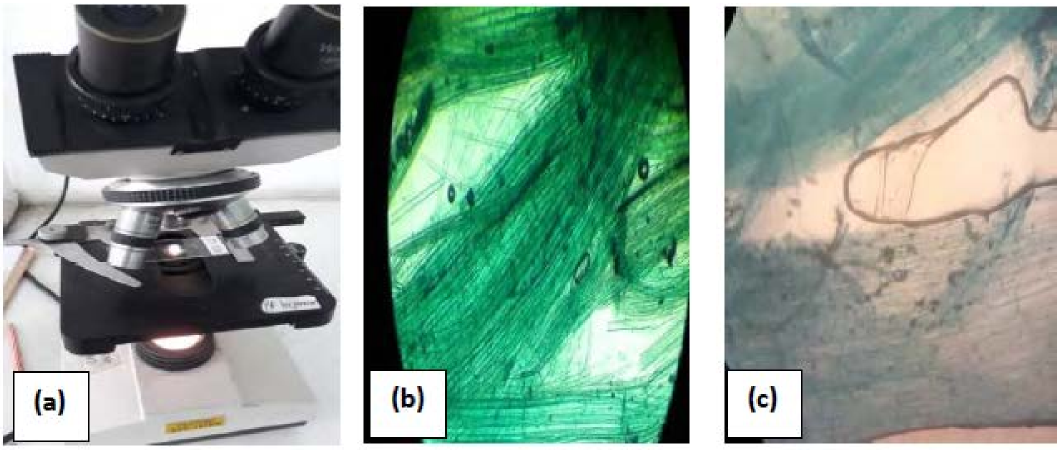

Figure 6. Stages of preparation for root staining and observation of AMF colonization

Where: (a). Observation of colonization using a microscope, (b) Appearance of mycorrhizal hyphae on roots of sweet corn plants, (c) Appearance of mycorrhizal infections in root cells of sweet corn plants.

3.7.11. Root Volume (ml)

Root volume was determined by determining the initial volume of water to insert into the measuring cup, inserting the roots into the measuring cup and then recording the increase in water volume after inserting the roots into it (Munarso, 2011).

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1. Conclusions

1) Provision of corn waste compost had no significant effect on plant height, number of leaves, stem diameter, flowering age, cob length, plant production and root volume of sweet corn plants.
2) Provision of microiza gave a very significant effect on plant height and number of leaves, but had no significant effect on stem diameter, flowering age, cob length, plant production and root volume of corn plants. The M3 treatment with 10 g per plant was the treatment that had the highest value, but was not significantly different from the M1 treatment using 5 g per plant.
3) The interaction of corn waste compost with mycorrhizae had no significant effect on plant height, number of leaves, stem diameter, flowering age, cob length, plant production and root volume of sweet corn plants.

5.2. Recommendations

Based on the results of the study, further studies regarding the provision of corn waste compost combined with other organic materials are necessary to do. This study recommends use of mycorrhizae as much as 5 g per plant to increase plant height and number of leaves combined with organic matter having sufficient nutrients for growth and production of sweet corn plants.

PROOFREADING

1.	largest	:	the most significant
2.	promising	:	good
3.	source	:	the source
4.	the maximum	:	maximum
5.	burned	:	is burned
6.	usable	:	used
7.	the total	:	total
8.	usable	:	useful
9.	increasing of plant	:	increasing plant
10.	symbiotic	:	symbiotics
11.	study	:	a study
12.	data of the Ministry	:	data from the Ministry
13.	waste	:	a waste
14.	value added	:	value-added
15.	Utilization	:	The utilization
16.	Value added	:	value-added
17.	ingredient	:	ingredients
18.	engineering	:	the engineering
19.	less	:	fewer
20.	While	:	At the same time
21.	compost producing	:	compost-producing
22.	study	:	the study
23.	selection	:	the selection
24.	Increasing of the growth	:	Increasing the growth
25.	main	:	primary
26.	important	:	essential
27.	good	:	suitable
28.	largest	:	most significant
29.	clear	:	evident
30.	mostly	:	mainly
31.	key	:	vital
32.	perfectly	:	ideally
33.	properly	:	adequately
34.	same	:	exact
35.	a very wide	:	an extensive
36.	greatly	:	significantly
37.	largely	:	primarily