RESPON PERTUMBUHAN DAN PRODUKSI TANAMAN BAWANG MERAH (*Allium ascalonicum* L.) DENGAN APLIKASI KOMPOS ECENG GONDOK DAN FUNGI MIKORIZA ARBUSKULAR

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MEDAN
2021

ABSTRACT

This study aims to determine the effect of the growth response and production of shallot (*Allium ascalonicum* L.) with the application of *Eichhornia crassipes* compost and arbuscular mycorrhiza fungi, carried out in the experimental garden of the Faculty of Agriculture, University of Medan Area, which is located at Jalan PBSI No. 1 Medan Estate, Percut Sei Tuan District from November to January 2020. The research method used was factorial randomized block design (RAK), namely the treatment factor of giving *Eichhornia crassipes* compost (E) with 4 levels, namely: E0 = No treatment, E1 = *Eichhornia crassipes* compost 0.5 kg/m^2 (5 tons /ha), E2 = *Eichhornia crassipes* Compost 1.0 kg/m^2 (10 tons/ha), E3 = *Eichhornia crassipes* Compost 1.5 kg/m^2 (15 tons/ha) and application factor of arbuscular mycorrhiza fungi consisting of 4 treatment levels, namely: M0 = No AMF inoculants (Control), M1 = 10 g/m^2 AMF inoculants (100kg/ha), M2 = 15 g/m^2 AMF inoculants (150kg/ha), M3 = 20 g/m^2 AMF inoculants (200kg/ha).The results showed that the application of water hyacinth compost at a dose of 15 tons/ha gave the highest yield to increase plant height, number of tillers, tuber wet weight per sample, tuber wet weight per plot, tuber dry weight per sample, tuber dry weight per plot. onion plant. Arbuscular mycorrhiza fungi application treatment with a dose of 200 kg/ha gave the highest yield in increasing plant height, number of tillers, wet weight of bulbs per sample, wet weight of bulbs per plot, dry weight of bulbs per sample, dry weight of bulbs per plot of shallots.

Keywords: Shallots (*Allium ascalonicum* L.), *Eichhornia crassipes* compost, Arbuscular mycorrhiza fungi

CHAPTER I

INTRODUCTION

1.1 Background of Study

Shallots (Allium ascalonicum L.) is one of the horticultural crop commodities that is widely consumed by the public as a mixture of cooking spices after chili. Apart from being a mixture of cooking spices, shallots are also sold in processed forms such as shallot extract, powder, essential oil, fried shallots and even as a medicinal ingredient to lower cholesterol levels, blood sugar, prevent blood clots, lower blood pressure and improve blood flow. As a horticultural commodity that is widely consumed by the public, the potential for the development of shallots is still wide open not only for domestic needs but also abroad (Suriani, 2011).

According to data from the Central Statistics Agency (CSA, 2019), the production of shallots in Indonesia in 2015 was 1,229,189 tons, in 2016 production increased to 1,446,869 tons, in 2017 production increased by 1,470,155 tons, in 2018 its production increased to 1,503,438 tons, in 2019 its production increased to 1,580,427 tons.

According to Iriani (2013), stated that the main producers of shallots are North Sumatra, West Sumatra, West Java, Central Java, East Java, West Nusa Tenggara, Central Sulawesi, and South Sulawesi. Five shallot-producing provinces in Java, consisting of West Java, Central Java, Special Region of Yogyakarta, East Java, and Banten, contributed 78.1% of the total national shallot production.

At this time, the increase in shallot production is generally highly dependent on inorganic fertilizers which provide high yields but in fact cause many problems of environmental damage (Reijntjes, 1999 in Edawati, 2017). Continuous application of inorganic fertilizers can result in decreased land productivity, one way to overcome further impacts that will arise from the use of inorganic fertilizers is through the provision of organic matter. Excessive application of inorganic fertilizers at the farm level causes land productivity to decline (Dewi, 2012). Therefore, organic matter acts as a balancing material that can absorb some substances so that excessive compounds do not damage plants (Dewi, 2012).

One of the organic materials that can also provide nutrients for plants is water hyacinth. Water hyacinth is a type of aquatic plant that lives floating on the surface of the water. Water hyacinth is a plant with a very fast growth rate and has a fairly large population, namely in 1 ha it can reach 125 tons of water hyacinth, and is able to cover the entire surface of the water. Water hyacinth is not only negative (weed) but can be used as a useful plant as an alternative to organic matter, because its availability is quite abundant when compared to other organic materials such as manure whose prices continue to increase. Water hyacinth can be used as raw material for organic fertilizer, because it contains quite high N, P, K. Wahyudi Komara (2016), stated that fresh water hyacinth has a composition of 36.59% organic matter, 21.23% organic C, Total N 0.28%, total P 0.0011% and K total 0.016%.

To increase nutrient absorption in shallot plants, the application of water hyacinth compost needs to be combined with the application of arbuscular mycorrhizal fungi (Mardatin, 2002). Mycorrhizae are associations between plants and fungi that live in the soil. The use of AMF as a biological fertilizer has recently begun to receive attention, this is not only due to its ability to increase the absorption of water and nutrients from the soil, to produce growth-promoting hormones and as a barrier to attack by soil-borne pathogens, but on the other hand AMF also plays a role in maintaining preservation of the soil both physically, chemically and biologically so that the biological balance is always maintained (Hartoyo et al., 2011). There are at least five benefits of mycorrhizae for the development of the host plant, namely increasing nutrient absorption from the soil, as a biological barrier against root pathogen infection, increasing host resistance to drought, increasing growth-promoting hormones, and ensuring the implementation of biogeochemical cycles. In this symbiotic relationship, the fungus gets the nutritional benefits (carbohydrates and other growth substances) for its life needs from plant roots. The effectiveness of AMF is highly dependent on the suitability between the factors of AMF type, plants and soil as well as the interaction of these three factors (Husna, 2015).

Based on the previous background, the researcher have conducted a research on the Application Response of Water Hyacinth Compost and Arbuscular Mycorrhizal Fungi to the Growth and Production of Shallots (Allium ascalonicum L.).

1.2 The Formulation of Problems

1. Does the application of water hyacinth compost with various doses affect the growth and production of shallots?

2. Does the application of various doses of arbuscular mycorrhizal fungi affect the growth and production of shallots?

3. Does the combination of application treatment of water hyacinth compost and dose of arbuscular mycorrhizal fungi affect the growth and production of shallots?

1.3. The Aim of Study

1. To obtain the application dose of water hyacinth compost on the growth and production of shallots.

2. To obtain the application dose of arbuscular mycorrhizal fungi on the growth and production of shallots.

3. To determine the effect of the combination of application of water hyacinth compost application and arbuscular mycorrhizal fungi on the growth and production of shallots.

1.4. Hyphotheses

1. The application treatment of water hyacinth compost has a significant effect on increasing the growth and production of shallots.

2. The application treatment of arbuscular mycorrhizal fungi had a significant effect on increasing the growth and production of shallots.

3. The interaction between the application of a dose of arbuscular mycorrhizal fungi and the application of a dose of water hyacinth compost significantly increased the growth and production of shallots.

1.5 The Significance of Study

1. As one of the requirements for obtaining a bachelor's degree in agriculture in the Agrotechnology study program, Faculty of Agriculture, University of Medan Area.

2. As information material for those who need it about the effect of application of water hyacinth compost and arbuscular mycorrhizal fungi on the growth and production of shallot (Allium ascalonicum L.).

CHAPTER II

LITERATURE REVIEW

2.1 The Economic Value of Shallots

Shallots (Allium ascalonicum L.) is a type of plant that is used as a spice in various cuisines in the world. Shallots have a high economic value. Shallot bulbs can be eaten raw, for cooking spices, pickles, traditional medicine, the skin of the tubers can be used as a coloring agent, the leaves can also be used to mix vegetables, and the flower stalks can also be mixed with vegetables or with instant noodles (Rukmana, 2007 in Valentina Theresia et al, 2016).

2.2 Taxonomy of Shallots (Allium ascalonicum L.)

Shallots (Allium ascalonicum L.) is an annual plant that forms clumps and grows upright with a height of 15-40 cm. According to Tjitrosoepomo (2010), shallots can be classified as follows:

Kingdom: Plantae

Division: Spermatophyta Subdivision :Angiospermae Class :Monocotyledonae

Order: Liliales

Family: Liliaceae

Genus: Allium

Species: Allium ascalonicum L.

2.3 Morphology of Shallots

Morphologically, shallots parts are distinguished by roots, stems, leaves, flowers, fruits and seeds. The roots of the shallot consist of the primary root which functions as a place for adventitious roots to grow and the root hairs which support the establishment of the plant and absorb water and nutrients from the soil. The roots can grow to a depth of 30 cm, are white in color, and if squeezed, they have a pungent smell like the smell of shallots (Pitojo, 2003).

The stem of the shallots is a small part of the whole buds. The bottom of the disc is where the roots grow. The top of the true stem is a pseudo tuber, in the form of a bulb (bulbus) derived from a modification of the base of the shallot. The base and part of the petiole are thickened, soft and fleshy, serving as food reserves. If the plant grows shoots or saplings, it will form several bulbs that coincide, known as "cloves". Clove growth usually occurs in shallots propagation from tuber seeds and less commonly occurs in shallots and seed propagation. The color of the tuber skin varies, some are pink, dark red, or yellowish, depending on the species. Shallots bulbs emit a pungent odor (Wibowo, 2009).

Shallots are relatively short-stemmed, light green to dark green, cylindrical in shape like an elongated and hollow pipe, with a tapered tip, measuring more than 45 cm in length. In the newly sprouted leaves are usually not visible cavities. This cavity is clearly visible when leaves grow big. The leaves on this shallot serve as a place for photosynthesis and respiration. So that directly, leaf health is very influential on plant health. After the old leaves turn yellow, they are no longer as erect as the young leaves, and eventually dry up starting from the bottom of the plant. After drying in the sun, the leaves of the shallot are relatively firmly attached to the bulbs, making it easier to transport and store (Sunarjono, 2003).

Shallot flowers consist of flower stalks and flower bunches. The flower stalk is slender, round, and has a length of more than 50 cm. The base of the flower stalk at the bottom is slightly swollen and the top stalk is smaller. At the end of the stalk there is a head-shaped part and a slightly pointed tip, namely a bunch of flowers that are still wrapped in a sheath. After the sheath opens, the bunches will gradually appear and flower buds with a stalk size of less than 2 cm will appear (Sumadi, 2003).

The sheath remains firmly attached to the base of the bunch and dries like paper, not falling off until the flowers bloom. The number of flowers can be more than 100 buds. Flower buds bloom not simultaneously. From the first blooming until the flowers in a bunch bloom all it takes about a week. Flowers that have been in full bloom are shaped like umbrellas (Pitojo, 2003). Shallot flowers are perfect flowers, have stamens and pistils. Each flower consists of six white petals, six yellowish-green stamens, and a pistil has very small and short or rudimentary pistils, which are thought to be sterile flowers. Even though the number of flower buds is large, relatively few flowers are successful in conducting pollination (Wibowo, 2009). The ovule of a shallot looks like a dome, consisting of three chambers, each of which has an ovule. Flowers that successfully carry out fertilization will grow to form fruit, while the other flowers will dry up and die. Shallots are round in shape, in which there are seeds that are slightly flat and 8 small in size. When they are young, the seeds are clear white and when they are old they are black (Pitojo, 2003).

2.4 The Requirement of Shallots Growth

2.4.1 Climate

Shallots are not drought tolerant because of their short root system. Meanwhile, the need for water, especially during the growth and formation of tubers is quite a lot. On the other hand, shallots are also the least resistant to rain, places that are always wet or muddy. Shallots should be planted in the dry season or at the end of the rainy season. Thus, shallots during their life in the dry season will be better if the irrigation is good (Wibowo, 2009).

Shallots can grow and produce well in the lowlands to the highlands of approximately 1100 m above sea level (ideal 0–800 m). The best production is produced in the lowlands which is supported by air temperatures between 25-32oC and a dry climate. To be able to grow and develop properly, shallots need an open place with 70% lighting, 80-90% air humidity and 300-2500 mm of rainfall per year (BPPT, 2007).

Wind is a climatic factor that affects the growth of shallots because the root system of shallots is very shallow, so strong winds can cause plant damage.

2.4.2 Land

According to Dewi (2012), shallots need fertile, loose soil that contains lots of organic matter with the support of sandy loam or dusty loam. The types of soil that are good for the growth of shallots are Latosol, Regosol, Grumosol, and Alluvial soil types with soil acidity (pH) 5.5–6.5 and drainage and aeration in the soil are running well, the soil should not be flooded by water because can cause rotting of tubers and trigger the emergence of various diseases (Sudirja, 2007).

On land that is often flooded, good drainage should be made. The degree of soil acidity (pH) is between 5.5–6.5, with an altitude of 0–1500 m above sea level. However, the most ideal altitude for cultivation is 0–600 masl above sea level. Because at this height, shallots will produce bulbs that are large and of good quality (Sartono, 2009).

2.5 Shallot Cultivation Techniques

Generally, the cultivation of shallots is done on land including the process of preparing seeds, processing land, planting, maintaining and harvesting.

1. Seed Preparation

Quality seed is one of the factors in the success of a farm. The requirements for good shallot seeds include: the shelf life of the seeds has been fulfilled, which is about 3-4 months, the harvest age is 70-85 days, the seed size is 10-15 g. The need for tubers per hectare is 1000-1200 kg.

The seed tubers are bright red, dense, not porous, not soft, not attacked by pests and diseases. Before planting, the tubers are cleaned, and if there are no visible buds, then the ends of the tubers are cut by 1/3 to accelerate the growth of shoots. In addition to tuber seeds, botanical seeds can also be used (TSS = true shalot seed). The advantages of using TSS include cheaper storage and transportation costs, less seed requirement of about 2 kg per ha, compared to tuber seeds, and can produce virus-free seeds (Erytrina, 2013).

2. Soil Cultivation

Tillage is generally required to loosen the soil so that the growth of bulbs from shallots is not hampered due to the physical properties of the soil which are less than optimal. Tillage is also carried out to improve drainage, level the soil surface and control weeds. On dry land, the soil is plowed or hoeed to a depth of 20 cm, then beds are made with a width of 1.2 m and a height of 25 cm, while the length depends on the condition of the land. The beds are made to follow the east and west directions for optimal light distribution (Marufah, 2010).

3. Cultivation

Seedling bulbs are planted with a spacing of 20 cm x 15 cm or 15 cm x 15 cm (recommended Balitsa). With a penugal tool, plant holes are made as deep as the average height of the bulbs. The bulb of the shallots (Allium ascalonicum L.) is inserted into the hole of the plant with a screw-like motion, so that the tip of the bulb appears flush with the soil surface. It is not recommended to plant too deep, because the tubers are easy to rot. After planting, the entire land is watered with a soft embrat (Sumarni and Hidayat, 2005).

4. Maintenance

Plant maintenance is done with actions to maintain plant growth. Among other things, as follows: Watering, the thing to note is that the shallot plant does not require a lot of rain because the bulbs of the shallot rot easily, but during its growth the shallot plant still requires sufficient water. Therefore, the shallot planting area needs intensive watering, especially if the shallot plantation is located on former rice fields. In the dry season, shallot plants require sufficient watering, usually once a day from planting until before the shallots harvest (Marufah, 2010).

Embroidery is done as soon as possible for dead/sick plants by replacing diseased plants with new seeds. This is done so that the production of a land remains maximal although it will reduce the uniformity of plant age (Marufah, 2010).

Pests that often attack shallots include armyworm (Spodoptera litura), trips, shallot caterpillar, purple spot (Alternaria porii), fusarium tuber rot and sclerotum white rot, Stemphylium leaf rot and viruses (Marufah, 2010).

5. Harvest

Shallots can be harvested after they are quite old, usually at the age of 70-75 days, with the characteristics of 60% soft stem neck, fallen plants and yellowing leaves. Harvesting should be carried out when the soil is dry and the weather is sunny to avoid tuber rot disease when the tubers are stored. Post-harvest handling is done by tying the stems to facilitate handling. Furthermore, the bulbs are dried in the sun to dry enough (1-2 weeks) under direct sunlight and then done by grading according to the size of the tubers. In the second stage of drying, the shallot bulbs are cleaned of soil and dirt. When it is dry enough (the moisture content is approximately 80%), the shallot bulbs are ready to be marketed or stored in the shallot packaging warehouse. Drying can also be done with a special dryer until it reaches a moisture content of 80% (Marufah, 2010).

2.6 Pests and Diseases of Shallots

Pests that often attack shallots are armyworms (Spodoptera litura). Diseases that often attack shallot plants are purple spot (Alternaria porii), Fusarium oxysporum tuber rot, sclenocium white rot, Stemphylium leaf rot and viruses (Marufah, 2010).

Pest and disease control is a routine activity or preventive action carried out by shallot farmers. Generally, this activity is carried out in the second week after planting and the last in the eighth week with an interval of 2-3 days. Pest and disease control is done by mechanical (manual) and chemical methods. Pest and disease control is carried out when the plant has an attack or signs of attack. In this control, manual is prioritized and if pest and disease attacks are above the threshold, chemical control is carried out by spraying.

2.7 Organic Ingredients

2.7.1 Definition of Organic Fertilizer

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

2.7.2 Compost

Compost is an organic fertilizer that decomposes slowly and 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 made from the decomposition process of the remains of living things (plants and animals). Compost not only adds nutrients, but also maintains the function of the soil so that plants can grow well. Production of commercial compost made from agricultural waste with organic fertilizer activator is a safe choice for some natural soil enhancers compared to chemical fertilizers (Al Barkah, et al., 2013).

Composting 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 less 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, pH, and aeration (Anyanwu, et al., 2013).

2.8 Water Hyacinth Compost

Water hyacinth (Eichhornia crassipes (Mart. Solm.) is a weed plant in aquatic areas that lives floating in deep water or develops roots in mud in shallow water. Water hyacinth reproduces very quickly, both vegetatively and generatively. Vegetative reproduction can double in 7-10 days. One water hyacinth stem in 52 days can grow to an area of 1 m2, or within 1 year it can cover an area of 7 m2. Heyne K. (1987), stated that within 6 months the growth of water hyacinth in an area of 1 ha can reach a wet weight of 125 tons.

Water hyacinth (Eichonia crassipes) is a type of floating aquatic plant that has a high growth speed so that this plant is considered a weed that can damage the aquatic environment. Water hyacinth can be used as organic fertilizer because there are nutrients needed by plants. Syawal (2010), stated that organic water hyacinth (E. crassipes) has a nutrient content of 1.86% N, 1.2% P, 0.7% K, 6.18% C/N ratio. , 25.16% organic matter and 19.61% C-organic.

The rapid propagation of plants causes water hyacinth to turn into weeds in several water areas in Indonesia. In the waters of the lake, water hyacinth grows on the edge of the lake from 5 m to as far as 20 m. Water hyacinth breeding is triggered by increased fertility in the lake water area (eutrophication), as a result of soil erosion and sedimentation, and agricultural waste.

According to Yustitia Akbar's research (2018), giving water hyacinth compost at a dose of 20 tons / ha is not only able to maintain soil fertility and increase production in tomato plants and is also able to reduce the supply that goes into the soil because it provides inorganic fertilizer materials continuously in the soil. long term especially in excessive amounts without providing organic matter other than being uneconomical, has the potential to reduce soil fertility, reduce microorganisms in the soil and accelerate land degradation.

2.9 Arbuscular mycorrhizal fungi

2.9.1 Taxonomy of arbuscular mycorrhizal fungi

The term mycorrhizae comes from the Latin myces (fungi) and Rhyza (root). Arbuscular Mycorrhizal Fungi (AMF) is one of the biological fertilizers which is defined as an inoculant with active living organisms that functions to bind/bind certain nutrients or facilitate the availability of nutrients in the soil for plants. Mycorrhizae are formed due to a mutualism symbiosis between fungi and plant root systems and both provide mutual benefits (Husna, 2015).

There are at least five benefits of mycorrhizae for the development of the host plant, namely increasing nutrient absorption from the soil, as a biological barrier against root pathogen infection, increasing host resistance to drought, increasing growth-promoting hormones, and ensuring the implementation of biogeochemical cycles. In this symbiotic relationship, the fungus gets the nutritional benefits (carbohydrates and other growth substances) for its life needs from plant roots. The effectiveness of AMF is highly dependent on the suitability between the factors of AMF type, plants and soil as well as the interaction of these three factors (Husna, 2015).

Arbuscular mycorrhizal fungi including endomocorrhiza are characterized by intracellular hyphae, namely hyphae that penetrate into the cortex from one cell to another. Inside the cell there are convoluted hyphae or branching hyphae called arbuscular structures. Arbuscular plays a role in facilitating the process of plant identification, whether infection has occurred in plant roots or not. Furthermore, it is said that all endophytes and those belonging to the genera Gigaspora, Scutellospora, Glomus, Sclerocystis and Acaulospora are capable of forming arbuscules. The main feature of

Document Accepted 28/5/22

AMF is the presence of arbuscular in the root cortex. Initially, the fungus grows between cortical cells, then penetrates the host cell wall and develops inside the cell (Suharno et al, 2016).

2.9.2 Classification of Arbuscular Mycorrhizal Fungi

Classification is the grouping of living things based on similarities and differences in morphology, anatomy, physiology, habitat, and distribution.

Classification is also known as Taxonomy. Classification AMF is one type of endomycorrhizal fungi that are included in the zygomycetes class with the order Glomales. The order Glomales consists of two sub-orders, namely: (1) sub-order Gigasporineae, family Gigasporaceae with two genera Gigaspora and Scutellospora, (2) sub-order Glomineae and consists of two families, namely Glomaceae with genera Sclerocity and Glomus, family Acaolosporaceae with genus Acaulospora and Entrosphospora .

AMF can be distinguished from ectomycorrhizae by observing the following characteristics: (a) the infected root system does not enlarge, (b) the fungus forms a thin and uneven hyphae layer structure on the root surface, (c) the hyphae invade into individual cortical tissue cells, (d) In general, hyphae branching structures called arbuscular and special oval-shaped structures called vesicles are found. There are six AMF types, namely: Glomus, Sclerocytis, Gigaspora, Scutellospora, Acaulaspora, and Entrophospora.

2.9.3 The Role of Arbuscular Mycorrhizal Fungi

Arbuscular mycorrhizal fungi affect the improvement of soil aggregates. AMF mycelium coated with glomalin can cause soil particles to stick to one another. Glomalin is a glycoprotein that can bind soil particles released by AMF hyphae. C excavated soil which is easily eroded by AMF is able to increase soil stability (Upadhyaya et al, 2010). AMF obtains a source of nutrients from root exudates (organic acids) and the host plant will benefit in the form of increased absorption of nutrients, especially P and water, plants are more resistant to drought, increases the hormone auxin so that it slows root aging and inhibits infection by pests in the soil. soil During the generative period, a lot of P nutrients are allocated for the process of forming seeds or plant fruit. Nutrient P is mostly used in the generative phase for the process of flowering and fruiting of plants (Suharno et al., 2016).

2.9.4 Mechanism of Nutrient Absorption by Arbuscular Mycorrhizal Fungi

AMF inoculated on plant roots will infect the roots. The process of root infection by AMF begins with the germination of spores that produce hyphae which then enter the root epidermis and develop intercellularly and intracellularly. Intracellular hyphae can penetrate root cortical cells and form arbuscular after the hyphae undergo branching. Arbuscular functions as a place for two-way nutrient transfer between the fungus and the host (Upadhayaya et al, 2010).

This arbuscular formation is influenced by the type of plant, the age of the plant, and the morphology of the plant roots. While the development of intercellular hyphae, hyphae will develop into vesicles filled with fatty fluid, as a food reserve for spores and at the same time as a resistant structure to maintain the survival of the fungus. Vesicles are usually more formed outside the cortical tissue in areas of long-standing infection (Upadhayaya et al, 2010).

As soil microorganisms, mycorrhizal fungi are key in facilitating the absorption of nutrients by plants. Mycorrhizae is a form of mutualism symbiosis between fungi and plant root systems. The role of mycorrhizae is to help the absorption of plant nutrients, increase growth and yield of plant products. On the other hand, fungi obtain energy as a result of assimilation from plants (Suharno and Sufati 2016).

Although AMF symbiosis with plants on fertile land does not have much positive effect, in extreme conditions it can increase plant growth. Mycorrhizae promote plant growth in low soil fertility, degraded land and help expand the function of the root system in obtaining nutrients. In particular, mycorrhizal fungi play an important role in increasing the absorption of low-mobility ions, such as phosphate (PO_4^-) and ammonium (NH_4^+) and other relatively immobilized soil nutrients such as sulfur (S), copper (Cu), zinc (Zn). , and also Boron (B). Mycorrhizae also increase the surface area in contact with the soil, thereby increasing the root absorption area up to 47 times, which makes it easier to access nutrients in the soil. Mycorrhizae not only increase the rate of nutrient transfer in the roots of the host plant, but also increase resistance to biotic and abiotic stresses (Khan, 2005).

2.9.5 Factors Affecting AMF Colonization

There are several things that affect infection from mycorrhizae (Sastrahidayat, 2011), namely:

1. Light

Microorganisms that live in symbiosis with plant roots obtain an energy source from the host plant, which also depends on the photosynthetic ability of the plant and photosynthetic translocation to the roots (Dhene, 1982). Increased light intensity generally increases the percentage of infection.

In addition, long irradiation time also increases the number of infected roots. Low light intensity can reduce root infection but its effect will be more visible in sporulation (Baon, 1996).

2. Temperature

Walking in a straight line with light, high soil temperatures lead to increased fungal activity. High temperatures usually favor infection and spore formation, while low temperatures are suitable for arbuscular formation (Fergusson and Woodheat, 1982 in Bintoro, 2008). The best air temperature for arbuscular development is around 30˚C, for mycelium colonization on the root surface between 24-34˚C, and for sporulation and vesicle development at 35° (Baon, 1996).

3. Soil Fertility

The elements in the soil that have the most influence on mycorrhizae are P, where a high P content in the soil will inhibit colonization (Sapphire and Duniway, 1982 in Bintoro, 2008). High soil N content also has a negative effect on the development and growth of mycorrhizae. The effect is related to the level of available N. The amount of dissolved N will determine the activity of mycorrhizae in the soil. The effect of N on mycorrhizae is also influenced by the availability of P in the soil (Hayman, 1982 in Bintoro, 2008).

4. Root Type

Plants with coarse root types and lacking root hairs are more often infected with mycorrhizae and their growth is more dependent on these mycorrhizae (Paul and Clark, 1989 in Sastrahidayat 2011).

2.9.6 Successful Use of AMF in Various Crops

AMF has been widely used to increase crop production, both plantation crops and horticultural crops. According to Dini's research (2015), the application of arbuscular mycorrhizal fungi at a dose of 20 g/plant of peanuts increased plant height 6 WAP, stem diameter, and degree of AMF infection. The interaction of AMF application and microbial consortium increased the peanut plant height by 2 WAP, root nodule weight and effective root nodule number. The highest root nodule weight and number of effective root nodules were found in the administration of 40 g of AMF and 15 g of rhizobium consortium.

According to research by Suswati et al (2013), the application of AMF (Glomus type-1, Acaulospora type-4, Glomus fasciculatum) can increase the resistance of Barangan banana plants to BDB. BDB propagule density was found in low amounts in the roots of banana plants colonized by indigenous AMF. The increase in banana resistance to BDB was closely related to the high percentage and intensity of AMF colonization and the intensive mycorrhizal structure (density of spores, external hyphae and internal hyphae) on the roots of the Barangan banana plant.

CHAPTER III

MATERIALS AND RESEARCH METHOD

3.1 Research Location and Time

This research was conducted in the experimental garden of the Faculty of Agriculture, University of Medan Area, which is located at Jalan PBSI No. 1, Medan Estate, Percut Sei Tuan Subdistrict with an altitude of ±22 masl, with flat topography and alluvial soil type and the Agrotechnology Laboratory, Faculty of Agriculture, University of Medan Area to observe AMF colonization. This research was conducted from November 2020 to January 2021.

3.2 Research Materials and Tools

The materials used in this research were; shallot seeds of Bima Brebes variety, arbuscular mycorrhizal fungi, EM4, Aquadest, 10% KOH, 16% HCl, metylane blue, water hyacinth plant, brown sugar, Rofral fungicide.

The tools used in this study were hoe, tripe, gembor, tape measure, plastic rope, measuring cup, knife, analytical scale, plastic, stationery, binocular microscope, glass preparations, tweezers, tissue, cover glass and object glass.

3.3 Research Method

The research method used was a factorial randomized block design (RAK), namely by giving water hyacinth compost and arbuscular mycorrhizal fungi.

1. Application of Water Hyacinth Compost Dosage consists of 4 levels of treatment, namely:

E0 = No treatment

E1 = Water Hyacinth Compost 0.5 kg/ (5 tons/ha)

E2 = Water Hyacinth Compost 1.0 kg/ (10 tons/ha) E3 = Water Hyacinth Compost 1.5 kg/ (15 tons/ha)

2. Application of Arbuscular Mycorrhizal Fungi Dosage consisted of 4 treatment levels, namely:

M0 = No AMF inoculants (Control)

M1 = 10 g/ AMF inoculants (100kg/ha) M2 = 15 g/ AMF inoculants (150kg/ha) M3 = 20 g/ AMF inoculants (200kg/ha)

Thus there were 16 treatment combinations, each consisting of:

E0M0	E1M0	E2M0	E3M0
E0M1	E1M1	E2M1	E3M1
E0M2	E1M2	E2M2	E3M2
E0M3	E1M3	E2M3	E3M3

This experiment was repeated 3 times with the following conditions:

$(tc-1)(r-1) \geq 15$

$(16-1)(r-1) \geq 15$

$15(r-1) \geq 15$

$15r - 15 \geq 15$

15r ≥ 15 + 15

15r ≥ 30

r ≥

30/1

5r ≥

2

r = 2

Research unit:

Number of repetitions = 2 replications

Number of experimental plots = 32 plots

Experimental plot size = 100 cm x 100 cm

Distance between experimental plots = 50 cm

Planting distance = 25 cm x 25 cm

Distance between tests = 100 cm

Number of plants per plot = 16 plants

Number of sample plants = 4 plants

Total number of sample plants = 128 plants

Total number of plants = 512 plants

3.4 Data Analysis Method

The data analysis method used for factorial Randomized Block Design (RAK) was as follows:

$$Y_{ijk} = \mu + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \sum_{ijk}$$

where :

Yijk = Observation results from each experimental plot that received treatment for factor 1 stage j and factor two levels placed in group i replication

μ = Effect of the general mean/average

α_j = Effect of giving Water Hyacinth Compost at level j

β_k = Effect of Arbuscular Mycorrhizal Fungi at level k

$(\alpha\beta)jk$ = Effect of treatment combination between giving water hyacinth compost at level j and Arbuscular Mycorrhizal Fungi factor at level k

$\sum_{ijk}$ = Effect of error from treatment with water hyacinth compost at level j and asrbuscular Mycorrhizal Fungi treatment at level k and replication at level i

To find out the effect of the treatment, a list of variances was compiled, and for the treatment that had a significant and very significant effect, it was continued with the mean difference test with Duncan's distance.

3.5. Research Implementation

3.5.1 Bulb Preparation

The shallot variety used in this study was the Bima Brebes variety obtained from Jalan Sambu. Before planting the top 1/3 of the shallot bulbs were cut using a knife, and air-dried for 2 days indoors to accelerate shoot growth.

3.5.2 Preparation and Making of Water Hyacinth Compost

In making water hyacinth compost, the stems, leaves and roots of the plant are used. Water hyacinth which will be used as compost is obtained from the drainage channel /ditch of the former PTPN II Hamlet V Bandar Setia Village, Percut Sei Tuan District as much as 90 kg, water hyacinth taken from that location is then placed on a bamboo rack for 3 days to reduce water hyacinth content. Furthermore, the water hyacinth plant was cut into pieces with a size of ± 5 cm. All pieces of water hyacinth are inserted into the composting hole which has been lined with plastic/tarpaulin with a size of 2 m x 2 m. Furthermore, the water hyacinth pieces were doused with a mixture of 250 g of brown sugar, 4 liters of clean water and 250 ml of EM4 bioactivator. Then the plastic sheeting is closed tightly. Once every 3 days, stirring is carried out so that the compost decomposes evenly. This activity is repeated until the compost is dark brown in color, has a crumb structure, has a loose consistency, and is not hot.

From the basic ingredients 90 kg of fresh water hyacinth produces 26 kg of water hyacinth compost. After the criteria have been met, the compost is analyzed for N, P, K, pH, C-org and C/N at the PPKS Laboratory, which is located at Jl. Brigadier General Katamso No. 51, Kp. New, District. Maimun Field. Medan City, North Sumatra. The results of the analysis of the nutrient content of water hyacinth compost conducted at the Central Laboratory of Palm Oil Research (PPKS), with the following analysis results: N= 1.74%, total P2O5= 0.74%, K2O= 2.23%, C-organic = 20.57%, C/N = 11.82.

3.5.3 Land Preparation

3.5.3.1 Land Clearing

The area of land required in this study is 13m x 7m. Land clearing is carried out by clearing weeds, plant residues, stones or wood that is in the field using a machete, tripe, sickle, fork or hoe.

3.5.3.2 Land Processing and Making Beds/Plots

Soil hoe to a depth of 20 cm while turning the soil. Tillage was carried out simultaneously by making a plot with a length of 100 cm x 100 cm with a height of 30 cm and a distance between beds of 50 cm and a distance between replicates of 100 cm. Beds made as many as 32 beds.

3.5.4 Water Hyacinth Compost Application

Water hyacinth fertilizer application was carried out 1 time at 1 week before planting according to the treatment dose. The application of compost is done by sowing around the points of the plants that have been marked with spikes. The purpose of applying it around the planting point is so that all planting points get water hyacinth compost evenly according to the treatment dose.

3.5.5 Arbuscular Mycorrhizal Fungi Application and Implanting

The dose of AMF inoculants that have been determined is applied at the time of planting shallot bulb seedlings. The AMF inoculants were inserted into the planting hole ± 3cm, then the top of the AMF inoculants was covered with planting media as thick as

1 cm. Then the seeds are placed on a layer of mixed planting media. Then covered with a layer of soil.

Planting is done with a spacing of 25cm x 25cm. Bulbs cut the top 1/3 and then planted in an upright position, then covered with thin soil.

3.5.6 Maintenance

1) Watering

Watering is done using a 5 liter size gembor with a watering system on the leaves and in the planting hole. Watering time is in the morning from 07.00 to 09.00 a.m. and in the afternoon from 05.00 to 06.30 p.m.. If it rains, then there is no need to water.

2) Embroidery

Firstly, prepare an insert plant plot which is next to the experimental plant plot. Then I planted 5 shallot bulbs for each treatment used in the prepared plot. Embroidery is carried out on shallot seedlings whose growth is poor or dead. Embroidery time at 1 MST to 2 MST.

3) Weeding and Hoarding

Weeding is done once a week which is done manually by pulling out the existing weeds so as not to disturb the plants in competition for nutrient absorption.

Pembubunan is done by loosening the soil around the shallot plants, then I collect it around the planting point of the shallot plants.

4) Follow-up Fertilization

Follow-up fertilization was carried out when the plants were 15 DAP. Follow-up fertilization was given by sowing NPK fertilizer as much as 7.5 g per plot, which was given evenly on the surface of the experimental plot.

5) Pest and Disease Control

Pest and disease control is done by mechanical (manual) and chemical means. Pest and disease control is carried out when the plant has an attack or signs of attack. In this control, manual is prioritized and if pest and disease attacks are above the threshold, chemical control is carried out by spraying fungicides. The fungicides used during the study were fungicides with the trademark Rofral (active ingredient: Alpha cypermethrin) with a dose of 1 ml/l water and Antracol 70 WP (active ingredient propineb 70%) with a dose of 2g/l water.

3.5.7 Harvest

Harvesting is done when the plant is 65 DAP which is characterized by yellowing, dry and fallen leaves, enlarged tubers and some have emerged to the soil surface, tuber segments have appeared solid and skin color has become shiny. Harvesting is done by pulling the plant out and then the plant is cleaned of all dirt.

3.6 Observation Parameter

3.6.1 Plant Height (cm)

Observations were made on the 2nd week after planting by measuring the height of the sample plants from the base to the tip of the highest leaf. Subsequent observations were made once a week until the age of 7 weeks. Plant height measurements were carried out using a meter.

3.6.2 Number of Tillers

The number of tillers was carried out two weeks after planting, by counting the number of tillers per plant every week starting from the plants 2 weeks after planting to 6 weeks after planting.

3.6.3 Wet Weight of Bulbs per Sample (g)

Wet weight of tubers per sample by weighing, which is done after harvest. Provided that the tubers are clean of soil and dirt.

3.6.4 Wet Weight of Bulbs Per Plot (g)

Bulb weight per plot was obtained by weighing, which was carried out after harvest. Provided that the tubers are clean of soil and dirt.

3.6.5 Bulb Dry Weight per Sample(g)

The dry weight of tubers per sample can be obtained by weighing the tubers after cleaning and air-drying, until the weight loss is 20%.

3.6.6 Dry Weight of Bulbs per Plot (g)

The dry weight of tubers per plot can be obtained by weighing the tubers after cleaning and air-drying, until the weight loss is 20%.

3.6.7 Colonization of AMF

3.6.7.1 Colonization Percentage

Root staining was carried out using the method according to Kormanick and McGraw, 1982. First, 15 pieces of roots were cut (1 cm) for each treatment and washed with tap water, then the root pieces were put into a test tube containing 10 ml of 10% KOH solution until the roots were stained. all submerged. The test tube containing the roots and 10% KOH was put into a measuring cup filled with water that had been heated on a hot plate for 30 minutes. The boiled roots were then cooled for a few minutes, then the KOH solution was removed and rinsed with tap water and neutralized with 10% HCL until the roots became white/clean. The roots were then stained with methylene blue, and stored for 24 hours. Next, the root pieces were placed on a glass object and 15 pieces were arranged and covered with a cover glass. The roots are then ready to be observed with a binocular microscope.

The percentage of AMF colonization was calculated using the slide method according to Giovannetti and Mosse, 1980. Long areas showing signs of colonization (there are vesicles and arbuscular or hyphae) are marked (+) while those without signs of colonization are marked (-). calculated based on the following formula:

$$\% \text{ kolonisasi FMA} = \frac{\text{Jumlah akar yang terinfeksi}}{\text{Jumlah contoh akar}} \text{x}100\%$$

The criteria for the percentage of root colonization can be seen in the table below:

Table 1. Criteria for the percentage of root colonization (Giovanmetri and Mosse, 1980) Setiadi et al., 1992

Class	Category
1	0–5% (very low)

2	6–20% (low)
3	27–50% (moderate)
4	51–75% (high)
5	76-100% (very high)

Source: The Institute of Mycorhiza Research and Development, USDA FirestService Feorgia (Setiadi *et al*., 1992).

3.6.7.2 Colonization Intensity

Observation of colonization intensity was carried out after harvest. Observation of the intensity of colonization was observed on the prepared roots (this observation was carried out simultaneously with the observation of the percentage of AMF colonization). The colonization intensity was calculated by the formula:

$$\%I = \frac{(95\ N^5 + 75\ N^4 + 30\ N^3 + 5\ N^2 + N^1)}{N}$$

I = Percentage of AMF colonization intensity

N = Total number of observed roots

N1-5 = Number of colonizations determined by class % colonization intensity

Table 2. Colonization Intensity Class Category

Class Category of Arbuscular Mycorrhizal Fungi Colonization Intensity		
Class	Score	Description
0	0%	Not colonized
1	1%	Slightly colonized
2	5 – 10%	Colonized
3	11 – 50%	Colonized
4	51 – 90%	Colonized
5	>90%	Colonized

Source: Sari, W. P (2019)

CHAPTER V

CONCLUSION AND SUGGESTION

5.1 Conclusion

1. The application of water hyacinth compost at a dose of 15 tons/ha gave the highest yield in increasing the growth and production of shallots.
2. The application treatment of arbuscular mycorrhizal fungi at a dose of 200 kg/ha gave the highest yield in increasing the growth and production of shallot.
3. The combination of water hyacinth compost application and arbuscular mycorrhizal fungi did not significantly affect the growth and production of shallots.

5.2 Suggestion

The highest treatment in the single treatment, namely treatment E3 and M3 was the best treatment in this study. The advice that the researcher can give is that future researchers should conduct further testing by increasing the dose of water hyacinth compost and the dose of arbuscular mycorrhizal fungi so that the growth and production of shallot can reach or exceed the plant description.