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Analysis of Shallot Growth and Production With Organic Fertilizer and Zeolite in Beach Sand Media

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ABSTRACT

Shallots are a horticultural commodity that is cultivated intensively by farmers. Efforts to increase shallot production are carried out through extensification of sand around the coast, which is marginal land. The addition of organic fertilizer and zeolite as a soil conditioner is one effort to increase the productivity of sandy land. This research aims to analyze the growth and production of shallots cultivated in sand media using organic fertilizer and zeolite. The research was carried out in the greenhouse of the Faculty of Agriculture, University of North Sumatra, Medan from December 2021 to April 2022. This research used a randomized block design with 2 factors, namely the first factor was the type of organic fertilizer (without organic fertilizer). fertilizer). , cow dung, chicken dung and goat dung).), the second factor is the zeolite dose (without zeolite application 7.5 tons/ha, 15 tons/ha and 22.5 tons/ha). The results of the research showed that the application of chicken manure had the best effect on increasing the growth and production of shallots, namely the variables observed were plant length, number of leaves, shoot dry weight, root dry weight, number of bulbs, bulb dry weight, and harvest index. The application of zeolite at a dose of 15 tons/ha increases the best growth and production of shallots which has a significant effect on plant length, number of leaves, and root dry weight and tuber dry weight. The interaction between organic fertilizer and zeolite did not have a significant effect on shallot productivity in sand media.

Keywords: horticulture plant; manure; sand; soil conditioner; zeolite.

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INTRODUCTION

Agricultural development in Indonesia is a priority considering that agriculture is a strategic sector that not only provides food needs, but also animal feed, pharmaceuticals, industry, as well as energy. Agricultural development cannot be separated from the issue of land availability. Good production is supported by the availability of sufficient land. On the other hand, the rate of population growth has an impact on the increasing need for food and residential land. Around 100,000 hectares of productive land per year experience conversion. To overcome this problem, agricultural extensification is carried out through land expansion on suboptimal land (Nugroho & Caturatmi, 2017; Wang et al., 2020). In Indonesia, the development of beach sand land for agriculture was carried out around the 1970s. Most of the development of sandy beach land is carried out on the southern coast of Java Island, mainly from Bantul (Yogyakarta) to Pangandaran (West Java), with an area of more than 150 km (Nugroho & Caturatmi, 2017; Sutardi, 2017).

Beach sandy land is one of the dry sub-optimal lands which is characterized by soil content with uniform grains and is a non-cohesive soil type that has loose intergranular properties. Other characteristics are low water holding ability, high infiltration and evaporation and low nutrient content. Apart from these limitations, sandy land has advantages, namely wide and flat expanses, free of flooding, abundant sunlight, shallow groundwater, neutral pH and groundwater, and easy land management (Rajiman, 2014).

Shallot is a high-value horticultural commodity that has the potential to be developed on sandy soil. With sandy soil conditions that have limited physical and chemical properties, this land has a marginal land suitability class, not suitable for shallot cultivation. Sandy soil also contains organic matter and total N is very low (Sutardi, 2017).

Amelioration technology that uses fixing agents consisting of manure and zeolite is an attempt to increase soil productivity in agricultural cultivation. Amelioration technology will improve soil physical properties, especially soil structure in forming soil aggregates and soil consistency so that the permeability properties of soil drainage and infiltration will be better and soil moisture will also be guaranteed. Thus, the nutrients provided through fertilization can be more efficient, also in terms of water use (Setiyono et al., 2014; Winarso et al, 2020).

Zeolite is a natural silicate mineral material that has a high CEC (120-180 meq/100g), has a bulk density of about 2.0 g/cm3 and is hollow with cavity sizes according to the size of the ammonium ion so that the zeolite can absorb ammonium ions before turning into nitrate. Zeolite minerals can increase the efficiency of

nitrogen fertilizers so that zeolites are considered capable of providing a good effect on improving beach sand soil. As a soil amendment that will be used, the amount of zeolite that needs to be given is around 10-20 tons/ha (Sutiman et al., 2020). Application of zeolite at a dose of 15 tons/ha increased Ca and Mg and decreased Sodium Adsorption Ratio (SAR) in Alfisol and Inceptisol soils and decreased Na in Alfisol and pH in Inceptisol soil. The application of zeolite can increase nitrogen uptake in both Alfisols and Inceptisols (Dewi et al., 2021). Shallots of the Crok Kuning variety with 15 tons/hectare of zeolite produced the highest tuber diameter. It is suspected that increasing the dose of zeolite affects the availability of soil moisture, thereby affecting the formation of tubers (Sutiman et al., 2020).

The use of fertilizers needs to be given in carrying out agricultural cultivation activities, so that the nutrient needs of plants can be met. Provision of organic fertilizers such as manure is very well used to improve the physical, chemical and biological properties of soil and is more friendly to the environment. Manure is a type of organic fertilizer that is widely used by farmers, such as cow, goat and chicken manure. The need for organic fertilizer in the form of manure ranges from 20-30 tons/ha (Ruswadi & Hasan, 2016). The results of the research by Sukmasari & Wijaya (2022), Nugraha et al. (2021) and Idris et al. (2018) showed that the application of several types of manure increased shallot production, namely in the observed variables plant height, leaf fresh weight, root dry weight, dry weight leaves and tuber fresh weight per plant. This study aims to analyze the use of organic fertilizers and zeolite to increase the growth and production of shallots in beach sand media.

MATERIAL AND METHODS

The study was conducted at the greenhouse of the Faculty of Agriculture, Universitas Sumatera Utara, Medan from December 2021 to April 2022. The planting medium used was beach sand from Labu Beach, Serdang Bedagai Regency with a distance of 30-35 m from the shoreline. The materials used were True Shallot Seed (TSS) shallots of the Lokananta variety, beach sand, chicken, cow and goat manure, zeolite, NPK, ZA and KCl fertilizers. The tools used are polybags with a volume of 4 liters, labels, analytical scales and rulers.

The research design used was a randomized block design with two factors, namely the first factor was the type of organic fertilizer (without organic fertilizer, cow manure, chicken manure and goat manure), the second factor is the dose of zeolite (without zeolite administration, 7.5 tons/ha, 15 tons/ha and 22.5 tons/ha). There were 16 treatment combinations with 3 replications, the number of sample plants per plot was 3 plants. The data obtained were analyzed by F test and the differences between treatments were further tested by Duncan's Multiple Range Test (DMRT) at 5% level.

The research began by analyzing the nutrient content of the planting medium and manure used in this study. Shallot seeds are sown for 41 days and can be moved when they have 3-4 leaves. Beach sand as a planting medium is filled into polybags and mixed with manure and zeolite according to the treatment set one week before planting. NPK fertilizer (16-16-16) at a dose of 100 kg/ha was given twice by pouring it evenly over the entire bed at the age of 4 and 6 weeks after planting (MST), while ZA fertilizer at a dose of 150 kg/hectare and KCl fertilizer at a dose of 187.5 kg/hectare were given one week after planting. Watering the plants is done in the morning and evening. Pest and weed control is done manually. Shallot bulbs are harvested after the upper 75% of the leaves turn yellow and start to droop, which is around 65-70 days after planting. Tubers that have been cleaned of soil residue, then dried in a room exposed to sunlight and has good air circulation for 7 days. The observed variables studied were plant length, number of leaves, shoot dry weight, root dry weight, number of tubers, tuber dry weight, and harvest index. Observation of plant length and number of leaves was carried out 7 weeks after planting, while other observed variables were measured after harvest.

RESULTS AND DISCUSSION

Analysis of Planting Media and Manure

The data in Table 1 shows the results of the analysis of nutrient content in beach sand used as a planting medium and three types of chicken manure. Beach sandy land is sub-optimal land which is land that naturally has low productivity. The main obstacle in the use of sandy soil is that it is poor in minerals, clay, organic matter and has a rough texture. Huang & Hartemink (2020) state that beach sand has the potential to be developed into agricultural land because the area of beach land is very large and has not been utilized optimally. Hasibuan (2015) of the Geospatial Information Agency (BIG) states that the total length of Indonesia's coastline is 99,093 km. Beach sandy land has the ability to provide excessive air, thus accelerating the drying and oxidation of organic matter.

The organic matter content of beach sand used as a planting medium is very low at 0.01% (Table 1). Organic matter is one of the soil conditioners that plays an important role in improving soil properties, both physical, chemical and biological soil properties. Physically improving soil structure, determining the level of development of soil structure and playing a role in the formation of soil aggregates, increasing the storage capacity of groundwater because organic matter has a high water holding capacity. Budiyanto (2021) and Hasibuan (2015) state that several studies have shown that the use of organic matter to improve beach sand soil has a significant effect on increasing total porosity, number of useful pores, number of pores for moisture storage and aggregate stability as well as reducing block density and permeability.

Table 1. Analysis of the nutrient content of beach sand and manure

Type of analysis	Unit	Beach sand	Cow Manure	Chicken Manure	Goat Manure	Analytical Method
C- organic	%	0,01	0,00	0,00	0,00	IK 0.1.5.0. (Spectrophotometry)
N-total	%	0,01	0,00	0,00	0,00	IK 0.1.6.0. (Kjeldahl)
P-Bray 1	ppm	13,01	0,00	0,00	0,00	IK 0.1.7.0. (Spectrophotometry)
K-dd	me/100 g	0,61	0,00	0,00	0,00	IK 0.1.8.0. (AAS)
pH		7,25	0,00	0,00	0,00	IK 0.1.3.0. (Electrometry)
C-organic	%	0,00	11,09	29,93	21,59	IK 0.3.13.0. (Graphymetry)
N-total	%	0,00	2,02	2,56	2,69	IK 0.3.14.0. (Kjeldahl)
P_2O_5	%	0,00	4,56	8,50	4,94	IK 0.3.15.0. (Spectrophotometry)
K_2O	%	0,00	1,82	4,11	5,90	IK 0.3.16.0. (AAS)

Manure is fertilizer that comes from cattle pens, either in the form of solid feces (feces) mixed with food scraps or urine. Manure can be classified into organic fertilizers which have advantages. Some of the advantages of manure so that it is very liked by farmers, such as improving soil structure and texture, increasing soil absorption of water, improving living conditions in the soil and as a source of nutrition for plants. The data in Table 1 shows the nutrient content of 3 different types of manure, chicken manure has a higher nutrient content and higher organic matter than cow manure and chicken manure. The results of Santoso et al's research (2021) also show that manure contains different nutrients. Manure contains different nutrients because each livestock has its own characteristics which are determined by the type of food and the age of the livestock.

Plant Length and Number of Leaves

The data in Table 2 shows that the application of organic fertilizers and zeolite has a significant effect on increasing plant length and number of leaves. Shallot plants fed with chicken manure produced the highest plant length and number of leaves and were significantly different compared to shallot plants given other organic fertilizers.

Differences in nutrient content are one of the factors causing differences in plant response to manure application. Based on the results of the analysis of the manure used, the N, P, K and C-Organic content in chicken manure was higher than other manure (Table 1). Chickens or poultry in general that are given rations that contain lots of protein and minerals will produce manure that has a high nitrogen and other mineral content as well. Rosadi et al (2019) stated that during the vegetative growth phase, plants really need a high intake of nutrients. Nitrogen is a nutrient that is needed by plants in large quantities, is an important element in the formation of chlorophyll and nucleic acids and plays an important role in the growth and development of all living tissues such as cell division and cell elongation thereby increasing plant height and increasing leaf blades.

Shoot Dry Weight and Root Dry Weight

Plant dry weight is the result of accumulation of net CO_2 assimilation carried out during plant growth and development. Plant growth can be considered as an increase in fresh weight and accumulation of dry matter. Dry matter accumulation also reflects the plant's ability to bind energy from sunlight through the process of photosynthesis and its interaction with other environmental factors. The data in Table 2 shows that the shoot dry weight and root dry weight of shallot plants significantly increased with the application of organic fertilizers. Shoot dry weight increased 41.88% and root dry weight increased 37.84% compared to no organic fertilizer. The results of the study by Susilawati et al. (2022) also showed that the application of chicken manure significantly increased plant dry weight. Karnilawati et al. (2021) stated that manure functions to increase water holding capacity, soil microbiological activity, cation exchange capacity values and improve soil structure, so that plant roots more easily penetrate the soil to obtain nutrients. Manure besides being able to improve soil chemical properties, improve the physical properties and biological properties of the soil. With the improvement of soil properties, plants can grow well.

Giving zeolite at a dose of 15 tons/ha significantly increased root dry weight by 27.50%, but zeolite application had no significant effect on increasing shoot dry weight. Marianti et al. (2019) state that root development is strongly influenced by soil structure, water and drainage in the soil which are very dependent on soil organic matter, allegedly with high doses of organic fertilizers given a good effect on the physical, chemical and biological properties of the soil. thereby affecting vegetative growth. If the nitrogen element needed by plants is sufficient, the plant's metabolic processes increase, one of which is in the process of photosynthesis, thus photosynthate translocation to the roots will also be large so that the plant's root system develops following the growth of the shoots, so that there will be a balance between crown and root growth.

Number of Tubers and Tuber Dry Weight

Beach sandy land is suboptimal land that requires improvement efforts to increase its productivity so that it can support plant growth and production. The purpose of this improvement is so that sandy soil can form aggregates, not loose, able to hold water either lost in the form of perlocation or evaporation, able to provide macro and micro nutrients for plants and the realization of soil micro richness that can help soil chemical and physical fertility.

Table 2. Plant length and number of shallot leaves treated with organic fertilizer and zeolite at the age of 7 weeks after transplanting in beach sand media

Treatment	Plant length (cm)	Number of leaves (strands)	Shoot dry weight (g)	Root dry weight (g)	Number of tubers (tuber)	Tuber dry weight (g)
Type of organic fertilizer :						
Without manure	38.22 d	7.78 d	1.91 c	0.037 c	1.00 b	3.50 c
Cow manure	40.19 c	8.50 c	2.11 b	0.048 b	1.00 b	5.29 b
Chicken manure	49.19 a	9.27 a	2.71 a	0.051 a	1.08 a	9.11 a
Goat manure	44.86 b	8.97 b	2.11 b	0.051 a	1.00 b	8.92 a
Zeolite Dosage						
0 ton/ha	40.63 c	8.36 d	2.26	0.040 c	1,00	5.53 c
7,5 ton/ha	43.19 b	8.55 c	2.25	0.044 b	1,03	6.48 b
15,0 ton/ha	44.69 a	8.94 a	2.02	0.052 a	1,03	7.65 a
22,5 ton/ha	43.94 b	8.66 b	2.32	0.051 a	1,03	7.16 a

Note: The numbers followed by different letters in the same column group show a significant difference in Duncan's Multiple Range Test at the level of α = 5%.

The data in Table 2 shows that adding organic matter and zeolite to beach sand media can increase shallot production. The highest number of tubers and tuber weights were produced from shallot plants fed with chicken manure. The number of tubers increased 8% and tuber weight increased 160.29% compared to without organic fertilizer. Applying organic fertilizer to beach sand media can improve the physical, chemical and biological properties of the soil so that it can significantly increase shallot production. Hijria et al. (2019) state that organic fertilizer is the best soil amendment compared to other amendments, its use apart from creating an environmentally friendly agricultural system can also reduce farmers' dependence on chemical fertilizers. Organic fertilizer improves soil structure, helps nutrient absorption, maintains temperature soil, increasing the buffering capacity of the soil against changes in pH, increasing cation exchange capacity, reducing P vixation and acting as a reservoir of secondary nutrients and microelements, as well as a source of energy for soil microorganisms which play an important role in the process of decomposition and release of nutrients in soil ecosystems.

Optimal production can be achieved by planting shallots in soil that has a crumb structure, moderate clay content, good drainage and sufficient organic matter. In addition to the addition of organic fertilizers, the addition of zeolite to the beach sand media can also increase the weight of the resulting shallot bulbs (Table 2) by 38.34% compared to the absence of zeolite. Rajiman et al. (2021) and Louhar et al. (2020) stated that the use of zeolite in sandy soil resulted in a change in the composition of the clay, although it had not been able to increase the texture class of the sand. The increase in water availability is caused by an increase in the amount of clay in the sandy soil. Clay that has large micro pores will result in increased water absorption. Likewise, the presence of clay will increase the weight of the soil in a certain volume, resulting in an increase in the unit weight of the soil.

Harvest Index

The character of the growth component and the yield component greatly affect crop production. The harvest index describes the ratio of photosynthates translocated to the generative part of the plant or the part of the plant that has the most economic value. The harvest index is a comparison between the dry weight of biological crops (dry weight of biomass) and economic yields. The harvest index is influenced by the amount of photosynthate translocation (Fan et al., 2019; Safriyani et al., 2018).

The results showed that the application of organic fertilizers had a significant effect on increasing the harvest index for shallots planted on beach sand media. The highest yield index was produced by shallot plants which were given chicken manure which increased by 39.66%. This is in line with the role of chicken manure which gives the best results on the parameters of the number of tubers and bobo tumbi. As the production quantity of shallots increases, the harvest index will also increase. The results of the same study were also conveyed by Safriyani et al. (2018) that the harvest index in rice has a real and positive correlation with grain weight per clump, meaning that an increase in the harvest index will be followed by an increase in grain weight per clump which is part of the economic value. The higher the grain weight produced will increase the rice crop index. A high harvest index value indicates that the plant is effective in accumulating photosynthate to seeds or other plant parts that have economic value.

CONCLUSION

Application of chicken manure had the best effect on increasing the growth and production of shallots, namely the observed variables were plant length, number of leaves, shoot dry weight, root dry weight, number of tubers, tuber dry weight, and harvest index. Application of zeolite at a dose of 15 tons/ha increased the growth and production of the best shallots which had a significant effect on the variable parameters of plant length, number of leaves, and root dry weight and tuber dry weight. The interaction between the application of organic fertilizers and zeolite did not significantly affect the growth and production of shallots in beach sand media.

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