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Effectiveness of water hyacinth compost and N, P, K, S fertilizer on S-available, S uptake, protein content, and yield of shallot in Inceptisols from Jatinangor

Abstract. Water hyacinth (*Eichhornia crassipes*) is a source of organic matter that can be used as compost to improve the soil quality and productivity of shallots. Shallots are horticultural commodities that have various benefits. Inceptisol soils dominate Indonesia, with an area of 37.5% of Indonesia's land area but have low soil fertility. Soil fertility can be increased by optimal fertilization. This experiment aimed to determine the dose of water hyacinth compost and nitrogen (N), phosphor (P), potassium (K), sulfur (S) fertilizer which gave the best effect on increasing available S, S uptake, protein content, and yield of shallots. The experiment was conducted from July to October 2021 at the Experimental Garden of the Laboratory of Soil Chemistry and Plant Nutrition, Faculty of Agriculture, Universitas Padjadjaran, Jatinangor. The experiment used a Randomized Block Design, consisting of seven treatments repeated four times. The recommended fertilizer doses used are 200 kg Urea, 500 kg ZA, 300 kg SP-36, and 200 kg KCl. The compost used was water hyacinth compost at a 25 t/ha dose. The results of this experiment showed that the treatment of ¾ compost + ¾ doses of N, P, K, and S was the best in increasing available S (26.79 mg kg^{-1}), S uptake (7.03 mg/plant), protein content (0.95%), colors and shallot yield (number of tubers, fresh weight, and dry weight) on Inceptisols from Jatinangor.

Keywords: Compost · N, P, K, S Fertilizer · Shallots · Water hyacinth

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Introduction

Indonesia has agricultural land dominated by the Inceptisol soil order, with an area that reaches 37,5% of Indonesia's land area or around 70,52 million ha (Setyastika and Suntari, 2019). West Java has an area of land with the Inceptisol order of 2.12 million ha that is used for agricultural activities (Puslittanak, 2000). Inceptisol soil has relatively low fertility and chemical properties, among other problems of acidic pH, high clay content, and the surface layer being easily washed away (Sudirja et al., 2006). The nutrient content of Inceptisol soil from Jatinangor in N-total 0.10% is included in the low category; P_2O_5 58.28 mg 100 kg^{-1} classified as high; K_2O 31.54 mg $100g^{-1}$ moderate; and SO_4 41.42 mg kg^{-1} which is low. Soil fertility plays an essential role in increasing crop productivity. Soil fertility can be increased by inputting nutrients into the soil. One of the treatments to increase soil fertility is optimal fertilization. Fertilizers commonly used are organic and inorganic fertilizers. The provision of organic and inorganic fertilizers is better than only providing inorganic fertilizers.

Research by Ramadhan et al. (2018) suggests that applying organic and inorganic fertilizers can increase the dry weight of shallots by 40.79% or 16.89 t/ha compared to without using organic fertilizers. Excessive application of inorganic fertilizers will cause damage to the physical, chemical, and biological properties of the soil. It will inhibit the activity of beneficial microorganisms in the soil. Hence, efforts need to be made to make additional inputs of organic fertilizers to reduce synthetic fertilizers' use on soil and plants.

The use of organic fertilizers will benefit the soil because they can improve the soil's physical, chemical, and biological properties and increase the activity of soil microorganisms and support environmental sustainability. One of the organic fertilizers that can be used is compost. Compost is an organic material that can be used to improve soil properties. Compost is obtained from plant residues and animal waste that microorganisms have decomposed to contain essential nutrients for plants (Setyorini et al., 2006) and relatively stable and straightforward genetic material (Sahwan, 2016).

Water hyacinth {*Eichhornia crassipes* (Martt.) *Solm*} is one source of organic matter that can be used to make compost. Water hyacinth is an aquatic weed that can be a source of problems for the environment, especially in water areas. Water hyacinth is a hyperaccumulator plant that can absorb heavy metals both in soil and in water (Widyasari, 2021), so it is necessary to do an initial analysis of heavy metal content in water hyacinth plants if it is to be used as a source of compost. Water hyacinth compost contains 16.94% C-organic, 13.56 C/N, 1.25% N, P_2O_5 1.31%, K_2O 0.39%, and S 6 122.68 mg kg^{-1}. Water hyacinth compost has a higher sulfur (S) content than compost made from various other raw materials, so it becomes an advantage of water hyacinth compost (Sofyan, 2014a). The high nutrient content in water hyacinth compost will support and improve soil quality and plant productivity, including shallots.

Shallot is a horticultural commodity with various benefits that can be used as spices, seasonings, and food additives. In addition, shallots are enriched with substances that are beneficial to humans, such as minerals, multivitamins, and sulfur which can prevent cancer (Syamsuddin and Hasrida, 2019). Thus, shallots are in demand and a mainstay of Indonesian society. Data from the Ministry of Agriculture (2020) showed that the consumption of red onions in Indonesia in 2019 reached 2.72 kg/capita/year.

Shallot production data for 2019 states that the demand for shallots will continue to increase in line with the community's increasing needs due to the population growth rate. Indonesia's shallot productivity potential can reach 20 t/ha. Data from the Central Bureau of Statistics (2019) states that the productivity of Indonesian shallots in 2019 only reached 9.93 t/ha, although the production increased in 2020. Therefore, efforts are needed to increase the productivity of quality shallot crops to maximize the potential for shallot production.

The quality of shallots is characterized by their characteristic red color, dense tubers with an oval shape, spicy taste, and distinctive aroma (Sumarni and Hidayat, 2014). The use of high-quality and high-yielding seeds is one of the factors in efforts to increase the productivity of quality shallots. Wide shallot varieties have been released with high yield potential and adaptability and can be planted in the lowlands, namely the Batu Ijo variety (Rahman et al., 2016). In addition to varieties, soil conditions and fertilization also affect the yields of shallot plants (Afliana, 2017). Shallots will grow well if planted

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in loose soil with high humus, well aerated, and quickly provides water. The desired soil type is clay with a balanced fraction of clay, sand, and silt, has an acidity (pH) of 5.6 – 6.5, and is most suitable for planting on alluvial soil (Hanafiah, 2008).

Sulfur is essential nutrient plants need (Zhao et al., 2015). Shallots require sulfur elements for growth and development (Assefa et al., 2015). Giving sulfur increases the fresh weight of the resulting shallot bulbs (McCallum *et al*., 2005). Lack of S will result in plant stunting, thinness, and leaves that will turn yellow.

The amino acids cystine, cysteine, and methionine contain sulfur which is essential in the formation, function, and structure of proteins. As a constituent of protein, Amino acids have a role for plants in transporting other substances, regulating organismal activity, cell response to stimuli, movement and protection against disease, and accelerating chemical reactions selectively (Neil, 2004). One source of S is water hyacinth compost. Water hyacinth has a reasonably high protein content, between 12-18%, with a relatively complete amino acid content (Little, 1997).

This study aimed to determine the effect and obtain the doses of water hyacinth compost and N, P, K, S fertilizers, which could increase available S, S uptake, protein content, and yield of shallots on Inceptisol Jatinangor soil. In order to reduce the use of inorganic fertilizers, a dose of ¾ compost + ¾ compost is the best treatment for increasing shallot crop yields.

Materials and Methods

This experiment was carried out on plastic-covered land in the Experimental Field of the Laboratory of Soil Chemistry and Plant Nutrition, Faculty of Agriculture, Universitas Padjadjaran, Jatinangor District, Sumedang Regency. The analysis of water hyacinth, soil, and plant compost was carried out at the Soil Fertility and Plant Nutrition Laboratory, Department of Soil Science and Land Resources, Faculty of Agriculture, Universitas Padjadjaran, Jatinangor District, Sumedang Regency, West Java. This experiment was carried out from June to October 2021.

The tools used in this experiment are polybag size 30 cm x 30 cm, analytical balance, caliper, cutter, laboratory equipment such as a spectrophotometer, digestion blocks, and other laboratory equipment.

The materials used in this experiment were soil media of the order Inceptisol originating from Jatinangor, water hyacinth compost, fertilizer Urea (46% Nitrogen), SP-36 (36% Phosphate), KCl (60% Potassium), dan ZA (21% Nitrogen, 24% Sulfur)with various doses that are adjusted to the treatment, the Batu Ijo variety of shallot seeds, and various chemicals needed such as HNO_3, $HClO_4$, $BaCl_2$-tween, activated carbon, sodium acetate, as well as other materials needed.

Experimental Design. This experiment was carried out using a Randomized Block Design (RBD), which consisted of one control treatment, two treatments giving recommended doses of fertilizers by Petrokimia (2011) for shallots (N, P, K, and ZA fertilizers as much as 200 kg Urea, 500 kg ZA, 300 kg SP-36, and 200 kg KCl), four combination treatments between water hyacinth compost and fertilizer N, P, K, S. Each treatment was repeated four times with two experimental units so that a total of 56 polybags with a spacing of 20 cm x 20 cm. The following is the treatment given:

Table 1. Arrangement of water hyacinth compost and N, P, K, S fertilizer treatment for shallots

Treatment	Information
A	Control
B	¾ N, P, K, S recommendations
C	1 compost
D	¼ compost + ¾ doses of N, P, K, S
E	½ compost + ¾ dose N, P, K, S
F	¾ compost + ¾ doses of N, P, K, S
G	1 compost + ¾ dose N, P, K, S

Analysis Plan. The experimental data were statistically processed using Fisher's test at a 5% significance level using the SPSS version 22.0 application. If the effect is significant, the test is continued with Duncan's Multiple Range Test or *Duncan Multiple Range Test* at an actual level of 5%.

Compost Making. The compost used comes from 70 kg of water hyacinth. Production begins with chopping or cutting the water hyacinth to a size of 3-5 cm to speed up the decomposition process. Then, 350 g of Orgadec bio activator was given, which was stirred evenly. The composting process was carried out anaerobically and observed for six weeks.

Preparation of Planting Media and Planting. The experiment was initiated by carrying out a complete analysis of the initial soil to obtain information on the soil's actual physical and chemical properties. The soil sample in this experiment was the soil of the order Inceptisols from Jatinangor, Sumedang Regency, West Java. Composite soil was taken at a 0-20 cm depth of 500 g. Drying was carried out on the planting medium, then pounded and filtered using a 2 mm sieve to obtain uniform soil grains. After that, the weight of the soil was carried out as much as 8 kg for each polybag so that the amount of land used in this experiment was 448 kg. Soil with the provision of compost fertilizer treatment is homogenized beforehand. The compost used in this experiment was water hyacinth compost at a dose of 25 t/ha or the same with 125 g/polybag so that the required water hyacinth compost is 2 kg.

Planting and Fertilization. Shallot planting is done by making a planting hole punched in the ground and planting one bulb per polybag. The size used is 30x30 cm. To stimulate tuber growth, cut the tip of the tuber by ¼ part of the tuber. Before planting, the tubers are cleaned first of the outer skin and remaining roots.

Fertilization is carried out using inorganic fertilizers, namely N, P, K, and ZA fertilizers which are applied at the beginning of planting and several intervals. At the time of planting, SP-36 and KCl fertilizers were applied. The frequency of Urea and ZA fertilization was twice, which was applied seven days after planting and 21 days after planting. Fertilizer application is made by: a sideband or next to a plant. The doses given are based on recommendations Petrokimia (2011) for shallots, namely N, P, K, and ZA fertilizers, as much as 200 kg of Urea, 500 kg of ZA, 300 kg of SP-36, and 200 kg of KCL. Each treatment was given a different dose.

Maintenance. Plant maintenance in this experiment was carried out with activities that included watering, weeding, controlling plant pests, and replanting. Watering is done in moderation according to field capacity and is done in the morning. Weeding is done physically by directly pulling the weeds around the planting medium. Control of plant-disturbing organisms is carried out by removing directly (manually) and applying (chemical) pesticides. Replacement of seeds that die at 0-14 days after planting and stitching is done.

Sampling. Shallots that have experienced the maximum vegetative phase or shallots aged 42 days after planting are then sampled to analyze the soil's chemical properties and nutrient absorption. Each treatment in all repetitions is observed. Samples are obtained by taking the culture media on polybags and homogenizing them to analyze soil chemical properties. Part of the plant is taken as a sample to analyze the nutrients in the plant tissue. The tuber yield was measured when the shallots were harvested late by weighing the tubers of each treatment.

Harvesting. Shallots have characteristics when they are ready for harvest, namely the base of the stem is soft and dry, the leaves fall ± 80% and turn yellow, the bulbs are fully filled, sticking out to the ground, and the color is purplish-dark red when it reaches 67 days after planting. The harvesting process is carried out when the soil conditions are dry, and the weather is sunny. After harvesting, the shallots are cleaned by separating them from the remaining soil attached and tying them to the surface of the leaves to make it easier to handle the harvest. Shallots that have been harvested are dried. The drying process was carried out for 14 days at room temperature. After air drying, weighing is carried out to determine the dry weight of the shallots.

Results and Discussion

S-available. The content of S-Available in Inceptisol soil from Jatinangor can be seen in Table (2). Based on the analysis of the available S content in shallots, it was shown that fertilizing with N, P, K, and S fertilizers with a combination of N, P, K, and S fertilizers and water hyacinth compost had a significant effect on available S.

This experiment produced the highest available S in the treatment of 1 compost + ¾ doses of N, P, K, S of 29.19 $mg.kg^1$ but not significantly different from the treatment of ¾ compost + ¾ doses of N, P, K, S. Giving 1 compost + ¾ doses of N, P, K, S is the best treatment because there is a cooperation between inorganic fertilizers and organic fertilizers (compost) in providing the nutrients needed by shallot plants. The lowest available S was in the control treatment of 5.69 $mg.kg^{-1}$.

Table 2. Effect of water hyacinth compost and N, P, K, S Fertilizer on S-availability of Inceptisol soil from Jatinangor

Treatment	S-available (mg kg^{-1})
A (Control)	5.69 a
B (¾ N, P, K, S recommendations)	13.72 b
C (1 compost)	11.22 b
D (¼ compost + ¾ dose N, P, K, S)	17.34 c
E (½ compost + ¾ dose N, P, K, S)	25.49 d
F (¾ compost + ¾ dose N, P, K, S)	26.79 de
G (1 compost + ¾ dose N, P, K, S)	29.19 e

Note: The numbers followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level.

The application of water hyacinth compost affects increasing the availability of S obtained from the decomposition of water hyacinth plants by microorganisms so that there is a balance of nutrients in the soil. The results of laboratory analysis showed that the S content in the water hyacinth compost used in this experiment was 6122.68 mg.kg^{-1}.

The increase in available S-content in the soil is due to the role of beneficial microorganisms such as *Thiobacillus* sp., which is an S-oxidizing bacterium, thereby stimulating the availability of S in the soil. Bacteria *Thiobacillus* sp. has an essential role in the soil as it oxidizes unavailable S to become available to plants through of stage $S^{O} \rightarrow S_2O_3^{2-} \rightarrow S_4O_6^{2-} \rightarrow SO_4^{2-}$ (Yang et al., 2010). Soil that was incubated with S-oxidizing bacteria gave result SO_4^{2-} which was higher in a faster time than soil that was not incubated with S.

In addition to compost, N, P, K, and S fertilizers can also provide S in the soil directly. The application of S fertilizer can increase the availability of S, which is higher than without S fertilizer (Matamwa et al., 2018). This is in accordance with research conducted by Nurhidayati et al. (2013), which stated that the availability of S by giving ZA 900 mg.kg^{-1} capable of increasing S-available 30.50 mg.kg^{-1} higher by 76% than without giving ZA, which is equal to 3.98 mg.kg^{-1}. Direct fertilizer application can provide direct availability of nutrients absorbed in the soil so that S availability increases.

S Uptake. Based on the S uptake analysis presented in Table 3, S uptake shows that the application of N, P, K, and S fertilizers and a combination of N, P, K, S fertilizers and water hyacinth compost have a significant effect on S uptake. Table 3 shows that the treatment 1 compost + ¾ doses of N, P, K, S resulted in the highest S uptake of 7.62 mg/plant while the control treatment produced the lowest S uptake of 4.48 mg/plant.

There is a relationship between the high S absorption resulting from the treatment and the availability of S in the soil (Hardjowigeno, 2010). This relationship can be proven in Table 3 that the treatment of 1 compost + ¾ dose of N has the highest available S compared to the other treatments in line with the results of S absorption in Table 3, which shows that the treatment of 1 compost + ¾ dose of N has the highest S uptake. The results of the S uptake of 1 compost + ¾ doses of N, P, K, S were not significantly different from the treatment of ¾ compost + ¾ doses of N, P, K, S. Based on the S uptake data (Table 3), the ¾ compost + ¾ doses N, P, K, S was the best treatment because it was able to increase S uptake by reducing the use of fertilizers.

Table 3. Effect of Water Hyacinth Compost and N, P, K, S Fertilizers on S Uptake of Inceptisol Soils from Jatinangor.

Treatment	S uptake (mg/plant)
A (Control)	4.48 a
B (¾ N, P, K, S recommendations)	5.72 bc
C (1 compost)	5.42 b
D (¼ compost + ¾ dose N, P, K, S)	5.84 bc
E (½ compost + ¾ dose N, P, K, S)	6.52 cd
F (¾ compost + ¾ dose N, P, K, S)	7.03 de
G (1 compost + ¾ dose N, P, K, S)	7.61 e

Note: The numbers followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level.

Applying water hyacinth compost and N, P, K, and S fertilizers gave high S absorption results when compared to the control treatment because it could supply nutrients, including S, in the soil so that more S in the soil could be absorbed. Pradhan et al. (2015) also showed that N, P, K, S (150, 50, 80, 45 kg/ha) gave high S uptake of up to 9.8 mg/plant four times greater than N, P, K fertilizer treatment recommendations (150, 50, 80 kg/ha). According the research of Sofyan (2014b) also applied 166.7 kg/ha of ZA fertilizer and 20 t/ha of water hyacinth compost, demonstrating the effectiveness of giving water hyacinth bokashi to lowland rice plants which were able to increase S uptake three times greater than the control treatment.

Plants need S because it is an essential nutrient to optimize plant growth. Sulfur has a role in the synthesis of proteins, vitamins and is closely related to the N metabolism needed by plants. A deficiency of element S will result in the growth of shallot plants not being optimal because shallot uptake is not optimal, causing a decrease in the yield and quality of shallots (Pradhan et al., 2015). In addition, the addition of water hyacinth compost affects improving soil physical properties such as soil structure, aeration, and better infiltration. Shallot plants require good soil conditions to grow optimally (Hendrawan et al., 2018). Good soil properties can support root growth to expand the range of nutrient absorption areas in the soil so that S uptake increases. Infiltration factors play an essential role in increasing S uptake by plants through mass flow.

Protein Content. The application of N, P, K, and S fertilizers and the combination of N, P, K, and S fertilizers with water hyacinth compost significantly affected shallot protein content. Table 4 presents the results of the statistical test of shallot protein content, showed that the treatment of 1 compost + ¾ doses of N, P, K, S resulted in protein levels tending to be higher than the other treatments of 3.07% but not significantly different from the treatment of ¾ compost + ¾ doses of N, P, K, S of 2.95 %. The control treatment had a lower protein content of 1.87% but was not significantly different from the 1 compost treatment of 1.97%.

The high protein content is affected by the availability of S in the soil, which plants absorb. Provision of compost and N, P, K, and S fertilizers have a role in increasing the protein content of shallots, especially elements N and S. The ZA fertilizer given to the treatment contains 24% S compounds and 21% N in the form of ammonium (Kiswondo, 2011). Nitrogen is a constituent element of protein (Nugraha, 2010) and plays a role in plant growth. Sulfur is a constituent of amino acid compounds that form proteins that function in the formation of chlorophyll and metabolic reactions of proteins, carbohydrates, and fats (Winarso, 2005). Amino acids in plant protein contain 90% of its element S. These amino acids function in improving the quality of shallots, namely aroma.

Table 4. The effect of water hyacinth compost and N, P, K, S fertilizer on shallot total protein in Inceptisol soil from Jatinangor

Treatment	Protein Total (%)
A (Control)	1.87 a
B (¾ N, P, K, S recommendations)	2.57 b
C (1 compost)	1.97 a
D (¼ compost + ¾ dose N, P, K, S)	2.72 bc
E (½ compost + ¾ dose N, P, K, S)	2.74 bc
F (¾ compost + ¾ dose N, P, K, S)	2.95 cd
G (1 compost + ¾ dose N, P, K, S)	3.07 d

Note: The numbers followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level.

The compost treatment + ¾ doses of N, P, K, S was the treatment that produced the highest protein content but was not significantly different from the ¾ compost treatment and ¾ doses of N, P, K, S, which was 2.95%, so the shallot crop needs in increasing protein are still sufficient by administering ¾ compost + ¾ doses of N, P, K, S. Based on these results, the best treatment that increases protein levels of shallots is the treatment of ¾ compost + ¾ doses of N, P, K, S due to the use of more fertilizer A little.

Red Onion Bulb Color. The color assessment of shallot plants through the chromameter test showed that the application of water hyacinth compost and N, P, K, and S fertilizers affected the color values of L* (brightness), b* (yellow-blue), and a* (blue-yellow). In this test, the L* values range from 0-100, a* and b* values have the same range from -100 to 100. A* values with negative values indicate green and cheerful indicate red, while b* with negative values indicating blue and positive values indicating yellow.

The color of shallots is produced from anthocyanin compounds. Anthocyanin compounds are organic chemical compounds that release color pigments such as red, blue, orange, and black in various parts of plants, namely tubers, seeds, flowers, vegetables, and fruit (Priska et al., 2018).

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Table 5. The effect of water hyacinth compost and N, P, K, S fertilizers on the color of shallot bulbs in Inceptisol soil from Jatinangor

Treatment	Color Value		
	L* (Brightness)	a* (Red Green)	b* (Blue-Yellow)
A (Control)	46.56 bc	22.65 ab	-5.22 a
B (¾ N, P, K, S recommendations)	46.20 bc	21.07 a	-5.71 a
C (1 compost)	43.43 a	23.96 ab	-4.82 a
D (¼ compost + ¾ dose N, P, K, S)	44.47 ab	24.45 b	-5.01 a
E (½ compost + ¾ dose N, P, K, S)	47.73 c	21.77 ab	-8.76 c
F (¾ compost + ¾ dose N, P, K, S)	46.14 bc	21.59 ab	-8.28 bc
G (1 compost + ¾ dose N, P, K, S)	48.12 c	21.28 ab	-6.35 ab

Note: The numbers followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level.

Table 6. Effect of water hyacinth compost and N, P, K, S fertilizer on shallot yield in Inceptisol soil from Jatinangor

Treatment	The Number of Tubers	Fresh Weight of Yield (g)	Dry Weight of Yield (g)
A (Control)	5.0 a	92.89 a	67.46 a
B (¾ N, P, K, S recommendations)	7.0 b	107.27 b	79.42 a
C (1 compost)	7.0 b	98.09 a	75.79 a
D ($\frac{1}{4}$ compost + ¾ dose N, P, K, S)	8.0 b	115.14 c	84.37 a
E (½ compost + ¾ dose N, P, K, S)	8.0 b	121.93 cd	101.72 b
F (¾ compost + ¾ dose N, P, K, S)	8.0 bc	124.82 de	102.90 b
G (1 compost + ¾ dose N, P, K, S)	9.0 c	132.26 e	107.01 b

Note: The numbers followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level.

Anthocyanins will work together with thiosulfate to stabilize the anthocyanin content in shallots. Thiosulfate compound also plays a role in the formation of color pigments in shallots (Sukasih and Mukadad, 2018). The element S forms the thiosulfinate compound (Forney, et al., 2010).

Water hyacinth compost also contains a high element of S compared to other composts, which affects the availability of thiosulfate compounds. This is also assisted by the availability of S in the soil, which results in increased S uptake in plants.

The low yield of shallots is affected by the absence of input given to the soil resulting in low nutrient availability and nutrient uptake in shallots. Nutrients that are not available will inhibit the growth and development of shallots.

Nutrient deficiency results in low shallot yields due to suboptimal growth and development of shallot plants. A lack of element N will inhibit the process of cell division and the formation of chlorophyll in plants (Lestari and Palobo, 2019). A deficiency of P and S elements causes plants to become stunted, thin, and have few leaves (Wati et al., 2015). A lack of K elements results in enzyme activity, protein formation, cell enlargement, and photosynthate transport to tubers (Lestari and Palobo, 2019).

The number of bulbs, fresh weight, and dry weight measured the shallot yield parameters. These parameters have been tested statistically, which is presented in Table 6. Based on the results of the statistical test results of shallots, it can be seen that the control treatment is the treatment with the lowest results on all observation parameters with a total of 5 bulbs; a fresh weight of 92.89 g; and a dry weight of 67.46 g compared to other treatments but not significantly different from the recommended ¾ N, P, K, S treatment; 1 Compost; and ¼ compost + ¾ doses of N, P, K, S.

Treatment of 1 compost + ¾ doses of N, P, K, S was the highest treatment with nine tubers; the fresh weight of 132.24 g; and dry weight of 107.01 g but not significantly different from the treatment with ¾ compost + ¾ doses of N, P, K, S. Thus, the ¾ compost + ¾ N, P, K, S treatment was the best treatment because it increased yields and reduced fertilizer use. Organic and inorganic fertilizers work together to provide the nutrients needed by plants. The addition of nutrients needed by plants can help synthesize proteins, nucleic acids, chlorophyll, and photosynthesis in plants (Havlin et al., 2016).

There was an increase in shallots because the required nutrients were met, such as N, P, K, S, and water hyacinth compost from the treatment given. Application of fertilizers N, P, K, S, and water hyacinth compost produced higher plant height, number of tubers, fresh weight, and dry weight of tubers and was significantly different compared to no treatment and compost application alone.

Each nutrient provides its role to support the growth and development of shallot plants so that it affects shallot yields. Nutrients N which support the vegetative period and protein formation in shallots, P elements which support root development, and K, which has a role in root and stem growth and protein formation (Havlin et al., 2016). The S element is essential in enlarging tubers and the number of tubers produced (Herwanda et al., 2017).

Water hyacinth compost also plays an essential role in increasing shallot yields. The application of compost can improve the soil's physical properties so that it affects the growth and yield of shallots on Inceptisol soil. Compost plays a role in soil aeration so that the soil pores increase, which increases air availability in the soil so that root penetration in absorbing nutrients increases. This also impacts the process of root respiration, which influences the growth and development of plant root systems (Hardjowigeno, 2010).

Conclusion

Applying water hyacinth compost combined with N, P, K, S fertilizers significantly increased the uptake of S, S-available, Protein, and yield of shallots, including color and fresh weight, dry weight, and the number of tubers.

Treatment of ¾ compost (18.75 t/ha) + ¾ doses of N, P, K, S (150 kg: 225 kg: 150 kg: 375 kg) was the best treatment capable of increasing available S (26.79 mg kg^{-1}), S uptake (7.03 mg/plant), protein content (2.95%), and shallot yield (fresh weight, dry weight, and the number of tubers) and red-purple color.

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