EFFECT OF WATER HYACINTH COMPOST AND NITROGEN, PHOSPHORUS, POTASSIUM, SULFUR FERTILIZERS ON S-AVAILABILITY, S-UPTAKE, AND QUALITY AND YIELD OF ONION (*Allium ascalonicum* L.) ON INCEPTISOLS OF JATINANGOR

ABSTRACT

Shallots are have a high potential in Indonesian agricultural land. Soil in Indonesia is dominated by Inceptisols, which is low in soil fertility. This can be managed by adding nutrients to soil to increase its fertility, which can have a good effect on quality and crop yields. This experiment's purpose was to find the dosage of water hyacinth compost and N, P, K, S fertilizers that can give the best results for available S, S uptake, quality,and the yield of Batu Ijo variety of shallots in Inceptisols of Jatinangor and were carried out in the Soil Chemistry Laboratory, Plant Nutrition Experimental Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang, West Java, Indonesia from June to September 2020. The experiment used a Randomized Completely Block Design (RCBD) with seven treatments and four replications, namely: control; Recommended N, P, K, S; ¾ Recommendations of N, P, K, S; ½ compost + ¾ dose of N, P, K, S; compost + ¾ dose of N, P, K, S; 1½ compost + ¾ dose of N, P, K, S; and compost + N, P, K, S at dosage of 25 t ha^{-1} water hyacinth compost, 200 kg urea, 500 kg Ammonium Sulphate, 300 kg SP-36, 200 kg KCl. The results showed that ½ compost + ¾ dose of N, P, K, S gave the best result by increasing S-avallability, S-uptake, aroma, color, number of bulbs, fresh weight, and dry weight of shallots bulbs on Inceptisols of Jatinangor.

Keywords: Shallots, Water Hyacinth, Compost, N, P, K, S Fertilizer, Inceptisols of Jatinangor

INTRODUCTION

Shallots (*Allium ascalonicum* L.) is often used because it can act as an antioxidant, contain many useful substances such as multivitamins, minerals, and folate compounds in the form of sulfur, which can prevent cancer (Syamsuddin and Hasrida, 2019).. This condition is not offset by shallot productivity which continues to decline in the period 2014 to 2018. It is recorded that shallot productivity in Indonesia decreases every year with an average annual decline of 1.60%, which was initially 10, 22 tons ha^{-1} to 9.59 tons ha^{-1}. The area of shallot in the same year on average, increased each year by up to 7.10%, in 2014 the harvested land area was 120,704 ha and in 2018 it was 156,779 ha (Director General of Horticulture, 2018).

The decline in shallot productivity can be caused by several factors because productivity depends on fertilizer, soil type, variety, season, and planting methods of shallot cultivation (Sumarni 2012 in Awami et al. 2018). Agricultural land in Indonesia is dominated by the Inceptisols land order which covers an area of 70.52 million ha or around 37.5% of Indonesia's land area and the West Java area has an Inceptisols order of around 2.12 million ha, which can be used for agricultural cultivation (Puslittanak, 2000).

To maintain and improve soil quality and fertility, inorganic fertilizers can be combined with organic manures. A balanced combination of organic and inorganic fertilizer can improve the quality of shallot bulbs and can make the bulbs less susceptible to attack by plant pest organisms (Dirgantari, et al., 2016). Another benefit of combination of organic and inorganic fertilizer is that it can maintain soil fertility and health, which has an effect on increasing plant productivity and the efficiency of using inorganic fertilizer (Sofyan, 2014). One of the organics fertilizer that has the potential to be used is water hyacinth compost. Water hyacinth can be used as compost, because the nutrient content of water hyacinth is quite high, 2.01% N, 2.51% P, 4.8% K, 18.71% C-organic, and a C/N ratio of 9,31 (Wulandari, *et al.*, 2016). Compost, whose raw material is water hyacinth has higher sulfur than compost made from other raw materials (Sofyan, 2014).

Sulfur (S) is an important part of the preparation of proteins. Organic sulfur is the main source for obtaining sulfur, which can help plant growth (Sofyan, 2014). Soil organic matter is the main contributor to sulfur in soil growing media, which is available and absorbed by plants. The decreasing amount of soil organic matter content is often thought to be the cause of reduced sulfur in the soil (Goenadi, 2000 in Sofyan 2014). This research aimed to determine the dosage of water hyacinth compost and N, P, K, and S fertilizer that could provide the best results for S-availability, S-uptake, quality, and yield of Batu Ijo variety shallots in Inceptisols of Jatinangor.

MATERIALS AND METHODS

1. Place and Time

The research was carried out at the Soil Chemistry Laboratory and Plant Nutrition Experimental Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor,. Sumedang, West Java from June to September 2020.

2. Materials and Tools

The materials used in this experiment were planting media in the form of Inceptisol soil from Jatinangor, shallot seeds of the Batu Ijo variety, compost from water hyacinth, and 200 kg of Urea, 300 kg of SP-36, 200 kg of KCl and 500 kg of Ammonium Sulfate as well as various chemicals required for S-availability and S-uptake analysis. The tools used in this experiment were polybags measuring 30 cm x 30 cm (1), analytical balance (2), caliper (3), cutter, and (40 laboratory equipment such as a spectrophotometer, chromameter, digestion block, and other laboratory equipment.

3. Experimental Design

The experimental design used in this research was Randomized Completely Block Design with one factor consisting of 7 treatments, namely: control (A), recommended N,P,K,S fertilizers (B), ¾ dose of N,P,K,S fertilizers recommendation (C), ½ compost + ¾ dose of N,P,K,S fertilizers (D), compost + ¾ dose of N,P,K,S fertilizers (E), 1½ Compost + ¾ dose of N, P, K, S fertilizers (F), and compost + dose of N,P,K,S fertilizers (G). Each treatment was repeated 4 times with 2 experimental units totaling 56 polybags. The design responses observed were S-available, S-uptake, aroma, color, and yield of shallots.

4. Sampling

Sampling of plants in the form of leaf organs was carried out, when the onion reached 5 weeks after planting to analyze S in shallot plants. Leaf samples were taken by cutting the base of the leaf using a cutter, then the sample was stored in a paper envelope to maintain the humidity of the sample, then the sample was analyzed for nutrient uptake in the laboratory.

Soil samples were taken before and after planting. Samples taken before planting were carried out to determine the initial soil analysis, while samples taken after planting were carried out to determine the S-available in soil after treatment was given. Soil samples after planting were taken from the area around the plant roots as much as 200 g and put in plastic to be tested for S-availability in the soil. Plant samples in the form of tubers were obtained from the shallot harvest. After harvest, shallot bulbs are weighed to obtain the crop yield in the form of fresh weight. The tubers were then air dried for 2 weeks, after which the tubers were weighed again to obtain the dry weight of the plant. The dried tubers are used for organoleptic tests, which can produce tuber aroma values and a chromameter test is carried out to get tuber color .

RESULTS AND DISCUSSION

1. S-Available in soil and S-Uptake

The results of research on the effect of water hyacinth compost and N,P,K, and S fertilizer on S-available and S-uptake are presented in Table 1.

Table 1. Effect of Water Hyacinth Compost and N,P,K,S Fertilizer on Soil S-Availablilty and S-Uptake

Treatment	S-Availability (mg kg^{-1})	S-Uptake (mg $plant^{-1}$)
A (Control)	4,03 a	1,16 a
B (N, P, K, S recommendation)	21,47 b	3,01 b
C (¾ N, P, K, S recommendation)	19,31 b	3,53 bc
D (½ Compost + ¾ dose N,P,K,S)	30,40 de	3,80 cd
E (Compost + ¾ dose N,P,K,S)	32,96 e	4,29 d
F (1½ Compost + ¾ dose N,P,K,S)	25,53 c	3,18 bc
G (Compost + N,P,K,S)	26,63 cd	3,80 cd

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

S- Availablilty in Soil

In Table 1, it can be seen that treatment E (combination of compost + ¾ dose of N, P, K, S) produces an S-availability content of 32.96 mg kg^{-1} and is the highest compared to other treatments, although the results are not significantly different from treatment D (½ Compost + ¾ dose of N,P,K,S) which produces available S as much as 30.40 mg kg^{-1}. This means that treatment with addition of ½ compost + ¾ dose of N, P, K, S is optimal in increasing available S in soil. Water hyacinth compost has a role in providing S in the form of organic, which can be utilized by beneficial microorganisms such as S-oxidizing bacteria (*Thiobacillus* sp.) to produce S in available form (SO_4^-) (Yang, *et al.,* 2010). According to Yang *et al.* (2010), soil containing *Thiobacillus* sp. can provide higher SO_4^{2-} results than those that do not contain *Thiobacillus* sp. Apart from the effect of water hyacinth compost, application of N, P, K, and S fertilizer plays a role in increasing S-availablilty in soil.

N, P, K, and S fertilizer can provide available nutrients directly into the soil, which will be absorbed by the soil and water hyacinth compost, this will cause enhanced S-availablilty in soil to increase. Research by Matamwa *et al.* (2018) showed that treatment with fertilizer containing S was able to increase S availability in soil. A similar finding was shown by Nurhidayati *et al*. (2013), application of Ammonium Sulphate (ZA) fertilizer was able to increase S-availability in soil up to 76,6% compared to treatments that did not receive additional Ammonium Sulphate fertilizer.

S-Uptake

The highest S uptake content in plants resulted from treatment E (compost + ¾ dose of N, P, K, S) with an S content of 4.29 mg plant^{-1}, but the results were not significantly from treatment D (½ Compost + ¾ dose of N,P,K,S), and the lowest content resulted from treatment A (control) of 1.16 mg plant^{-1} and the data is presented in Table 1. The S uptake by plant is directly proportional to the availability of S in soil (Hardjowigeno, 2010). This is proven by the results of available S in soil recorded by treatment D being the best, the same as the results of S uptake by the plants. This is because of addition of compost with N, P, K, and S fertilizer can provide nutrients available in soil, which can be absorbed directly by plant roots. These results are in conformity with Sofyan (2014) who, showed that giving bokashi water hyacinth compost and ZA fertilizer was able to increase S uptake in lowland rice up to 3x greater than control. Pardhan *et al.* (2015) showed that giving S fertilizer was able to increase S uptake 4x greater than control. This is possibly due to the function of S in onions in connection with protein synthesis, which is associated with N in metabolism, which can enable optimal root growth. A lack of element S can cause a reduction in yield, quality, and nutrient uptake of shallots (Pradhan *et al.*, 2015). Apart from the function of nutrients, the role of water hyacinth compost also influences increasing S uptake. Water hyacinth compost can improve soil physical properties such as aeration, infiltration, and soil structure which will influence better plant root development (Hendrawan *et al.*, 2018).

2. Color, Aroma, Wet Weight and Dry Weight of Shallot Plants

Research results on the effect of water hyacinth compost and N,P,K, and S fertilizers on color and aroma of onion, wet weight and dry weight of shallot plants are presented in Table 2.

Table 2. Effect of Water Hyacinth Compost and N,P,K,S Fertilizers on Color, Aroma, Wet Weight, and Dry Weight of Shallot Plants

Treatment	Color			Aroma	Number of Tubers	Wet Weight of Tubers (g)	Dry Weigthof Tubers (g)
	L* (Brightness)	a* (Green-Red)	b* (Blue-Yellow)				
A (Control)	35,56 a	14,75 a	-1,68 a	4,2 a	4 a	74,10 a	45,53 a
B (N, P, K, S recommendation)	42,16 a	21,39bc	-3,17 a	5,9 bc	7 b	95,19 b	63,30 b
C (¾ N, P, K, S recommendation)	42,36 a	20,20 b	-4,20 a	5,3 b	8 bc	96,28 b	62,10 b
D (½ Compost + ¾ dose N,P,K,S)	43,44 a	23,23 bc	-3,76 a	6,2 cd	8 bc	113,24 c	83,83 c
E (Compost + ¾ dose N,P,K,S)	43,10 a	22,92 bc	-3,75 a	6,6 d	9 c	117,41 c	89,38 c
F (1½ Compost + ¾ dose N,P,K,S)	42,88 a	22,14 bc	-3,59 a	6,2 cd	8 bc	102,60 bc	78,57 c
G (Compost + N,P,K,S)	42,31 a	24,03 c	-2,42 a	6,0 cd	8 bc	108,33 bc	80,68 c

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

Color

The color test was carried out using a Chromameter by measuring color from brightness (L*), which has a value range of 0 to 100 a blue-yellow color range (b*) and a green-red color range (a*) with a value of -100 to 100 and results on color test can be seen in Table 2. It can be inferred that the treatment does not affect the L* and b* values because statistically, they have values that are not significantly different between the treatments. The real effect of treatment was on a* color, where the control produced the lowest a* color value of 14.75 and the highest result was produced by the compost + N, P, K, S fertilizer treatment, which obtained an a* color value of 24.03 but there was no significant difference with standard N, P, K, S treatment; ½ compost + ¾ dose of N, P, K, S; compost + ¾ dose of N, P, K, S; and 1½ compost + ¾ dose of N, P, K, S; hence the best treatment to increase tuber color is the addition of ¾ N, P, K, S standard with a color value a* 21.39.

The color produced in shallots due to anthocyanin compounds. Anthocyanin compounds are organic chemical compounds that can produce red, blue, purple, orange, or black pigments in various tubers, seeds, flowers, vegetables, and fruit (Priska *et al.*, 2018). In shallots, anthocyanins are associated with thiosulfinates to maintain the stability of anthocyanin content. Thiosulfinate is also a pioneer compound in the formation of red pigment in shallots (Sukasih and Mukadad, 2018). Based on this understanding, S-available in soil can increase S uptake in shallots and affect color because, S is a constituent of thiosulfinates (Forney *et al.*, 2010). This is what causes the treatment with addition of compost and N, P, K, and S fertilizer to produce a* color that is significantly different from the control treatment.

Aroma

Based on the results of organoleptic tests, best treatment was produced by administering ½ water hyacinth compost + ¾ dose of N, P, K, S with a value of 6.2, which was classified as slightly pungent but the value was not significantly different from treatment of compost + ¾ dose of N, P, K, S; 1½ compost + ¾ dose of N, P, K, S and compost + doses of N, P, K, S. The aroma of shallots that got the lowest score was the control treatment with a score of 4.2 with specifications that were slightly less pungent. The distinctive aroma of shallots is pioneered by the compound S-alkenyl cysteine sulfoxides (ACSO). When this compound reacts with the allinase enzyme, both of them will produce ammonia, pyruvate, and thiosulfinate which give the characteristic taste and aroma of shallots (Forney *et al.*, 2010). The main component for the formation of ACSO compounds is S in shallots. Research by Forney *et al.* (2010) showed that fertilization with S was able to increase S uptake, which is affected the ACSO content in shallots, which is a compound that forms the aroma of shallots. This is what causes treatment with addition of water hyacinth compost and N, P, K, and S fertilizer to produce high S-availability and S uptake. This will make the aroma of shallots significantly different compared to those without fertilizer.

Shallot Crop Yield

The results on yield of shallot plants includes the number of bulbs, wet weight, and dry weight of bulbs are presented in Table 2. From the table, it can be seen that the control produced the lowest number of tubers, wet weight, and dry weight compared to the other treatments. This is likely due to the low availability and uptake of nutrients by shallots because, there is no contribution of nutrients to the soil. The unavailability of nutrients such as N, P, K, and S can hurt the growth and development of shallots. The best results on number of tubers, wet weight, and dry weight were obtained from the treatment of ½ compost + ¾ dose of N, P, K, S, the results were 8 saplings, 113.24 g wet weight, and 83.83 g dry weight respectively and not significantly different from compost + ¾ dose N,P,K,S treatment; 1½ compost + ¾ dose of N, P, K, and S; and compost + dose of N, P, K, and S. The addition of N, P, K, and S fertilizer with recorded organic fertilizer can produce higher and different plant height, number of tillers, fresh weight, dry weight of bulbs, and weight of onion stover significantly compared inorganic fertilizer or without treatment. (Suwandi et al. 2016; Supadma, *et al.*, 2020).

This cannot be separated from the role of each element N, P, K, and S for the growth and development of shallots, which can ultimately influence shallot yields. N plays a role in promoting growth and forming chlorophyll protein in shallots, P plays a role in root development, and K plays a role in root and stem growth and protein synthesis (Havlin *et al.*, 2016). Then, S has an essential function for shallot yield because one of its functions is to enlarge shallot bulbs and influence the number of bulbs produced (Herwanda, *et al.*, 2017). Water hyacinth compost has an important role in increasing shallot yields. Widodo and Kusuma's (2018) showed that compost improves soil physical properties, which correlate with plant growth and yield in soil of the *Inceptisol* order. Adding compost can make the soil firm, thereby increasing the pores in soil. This in-turn increase the availability of air in soil, which will increase root penetration to absorb nutrients because the root respiration process can influence the development and growth of plant roots (Hardjowigeno, 2010).

CONCLUSION

Providing a combination of water hyacinth compost and N,P,K, and S fertilizer can have a real influence on S-availability in soil , S uptake, aroma, color, and yield of shallots. The treatment of ½ compost + ¾ dose of N, P, K, S is the best in increasing S-availability, S uptake, aroma, and yield of shallots, while the best treatment for increasing shallot color is ¾ dose of standard N, P, K, S.

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