Original Research Article

THE EFFECT OF WATER HYACINTH COMPOST ANDN, P, K, SFERTILIZERS ON S AVAILABLE, S-UPTAKE, AND QUALITY AND YIELD OF ONIONS(*Allium ascalonicum* L.)ON INCEPTISOLS FROM JATINANGOR

Comment [L1]: The title is good, but don't abbreviate the letters Nitrogen, Phosfor, Kalium,Sulfur but write them in full

ABSTRACT

Shallots are horticultural crops that have a high potential to be developed in Indonesian agricultural land. Soil in Indonesia is dominated by Inceptisols which have low soil fertility. This condition can be handled by adding nutrients to the soil to increase soil 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 Jatinangor and were carried out in the Soil Chemistry Laboratory and Plant Nutrition Experimental Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang from June to September 2020. The experiment used a randomized completely block design (RCBD) with seven treatments and four replications, namely: control; Recommendations N, P, K, S; ¾ Recommendations 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 25 t ha^{-1}compost water hyacinth, 200 kg urea, 500 kg ZA, 300 kg SP-36, 200 kg KCl. The results showed that ½ compost + ¾ dose of N, P, K, S was the treatment that gave the best result to increase available S, S uptake, aroma, color, number of bulbs, fresh weight, and dry weight of shallots bulbs on Inceptisols *from Jatinangor*.

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

INTRODUCTION

Shallots (*Allium ascalonicum* L.) are a type of horticultural vegetable crop that is very often used by humans because it can act as an antioxidant, They contain many useful substances such as multivitamins, minerals, and folate compounds in the form of sulfur which can prevent cancer (Syamsuddin and Hasrida, 2019). BPS (2018) noted that from 2014 to 2018, the level of red onion consumption among Indonesian people increased every year by 2.93%, with the level of consumption in 2014 amounting to 2,487 kg $capita^{-1}$ $year^{-1}$ to 2,764 kg $capita^{-1}$ $year^{-1}$ in 2018. 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 harvested land 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). Efforts that can be made to increase soil fertility and chemical properties which are relatively low are by fertilizing. Fertilization in question is the addition of one or more available nutrients to maintain soil fertility, thereby increasing the quantity and quality of plants (Hardjowigeno, 2010).

To maintain and improve soil quality and fertility, inorganic fertilizers can be combined with organic fertilizers. A balanced combination of organic fertilizer 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 the combination of organic fertilizer 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 organic 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, namely 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 also has higher sulfur elements 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).

The 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 uptake, available S, quality, and yield of BatuIjo variety shallots in JatinangorInceptisols.

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 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 BatuIjo variety, compost from water hyacinth, and 200 kg of Urea, 300 kg of SP-36, 200 kg of KCl and 500 kg of ZA. as well as various chemicals required for S-available 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 (4), and laboratory equipment such as a spectrophotometer, chromameter, digestion block, and other laboratory equipment. (5).

3. Experimental Design

The experimental design used in this research was a Randomized Block Design (RAK) with one factor consisting of 7 treatments, namely: control (A), recommended N,P,K,S fertilizer (B), ¾ dose of N,P,K fertilizer,S recommendation (C), ½ compost + ¾ dose of N,P,K,S fertilizer (D), compost + ¾ dose of N,P,K,S fertilizer (E), 1½ Compost + ¾ dose of N fertilizer, P,K,S (F), and Compost + dose of N,P,K,S (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 WAP to analyze S in the 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 the 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-available in the soil.

Plant samples in the form of tubers were obtained from the shallot harvest. After harvest, the shallot bulbs are weighed using an analytical balance 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 values. Each sample was taken from each shallot planting, so there were a total of 56 samples of leaves, soil, and bulbs.

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 Available in the Soil and Plant S-Uptake

Treatment	S-Available (mg kg^{-1})	S-Uptake (mgplant^{-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 the 5% significance level.

S-Available in Soil

In Table 1 it can be seen that treatment E (combination of compost + ¾ dose of N, P, K, S) produces an available S 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 S-available as much as 30.40 mg kg-1. This means that treatment with the addition of ½ compost + ¾ dose of N, P, K, S is the optimal treatment in increasing S-available in the soil.

Water hyacinth compost has a role in providing S in the form of organic material which can be utilized by beneficial microorganisms such as S-oxidizing bacteria (Thiobacillus sp.) to produce S in available form (SO4-) (Yang, et al, 2010). According to Yang et al. (2010), soil containing Thiobacillus sp. can provide higher SO42- results than those that do not contain Thiobacillus sp. Apart from the effect of water hyacinth compost, the application of N, P, K, and S fertilizer also plays a role in increasing S-available in the 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 the S-available in the soil to increase. Research by Matamwa et al. (2018) showed that treatment with fertilizer containing S was able to increase S-available in the soil. A similar thing was shown by research by Nurhidayati et al. (2013), where the application of ZA fertilizer was able to increase S-available in the soil by up to 766% compared to treatments that did not receive additional ZA 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 different 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}. The data is presented in Table 1.

The content of S uptake in plants is directly proportional to the availability of S in the soil (Hardjowigeno, 2010). This is proven by the results of S-available in the soil produced by treatment D being the best, the same as the results of S uptake in plants. This is because the addition of compost with N, P, K, and S fertilizer can provide nutrients available in the soil which can be absorbed directly by plant roots. These results are by Sofyan (2014) in his research which showed that giving bokashi water hyacinth compost and ZA fertilizer was able to increase S uptake in lowland rice up to 3x greater than the control. Pardhan et al.'s research. (2015) also 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 as 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 from 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 fertilizer on color and aroma. The 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 Fertilizer on Color, Aroma, Wet Weight, and Dry Weight of Shallot Plants

Treatment	Color	Aroma	Number	Wet Weight	Dry Weigthof

					of Tubers	of Tubers (g)	Tubers (g)
	L* (Brightnes s)	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 tool 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. Results The color test can be seen in Table 2. In the table, it can be seen 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 the treatment was on the a* color where the control treatment 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; so 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 comes from 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 the 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 the 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 the 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, the 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 the 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 (Block, 1992 in 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 affected the ACSO content in shallots, which is a compound that forms the aroma of shallots. This is what causes treatment with the 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 Results

The yield of shallot plants includes the number of bulbs, wet weight, and dry weight of the bulbs. These results are presented in Table 2. In the table, it can be seen that the control treatment 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 from 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 for the 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 the 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 to just giving 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 research (2018) shows that compost affects improving 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 the soil. This will increase the availability of air in the 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, 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-available, S uptake, aroma, and yield of shallots, while the best treatment for increasing shallot color is ¾ dose of standard N, P, K, S.

Contributions

Comment [L2]: It is necessary to add the contribution of each author in this manuscript

REFERENCES

Awami, Shofia and Sa'diyah, Khalimatus and Subekti, Endah. 2018. Factors Affecting Red Onion (*Allium ascalonicum*) Production in Demak Regency. Agrifo: Malikussaleh University Agribusiness Journal. 3. 35. 10.29103/ag.v3i2.1115.

BPS (Central Statistics Agency). 2018. National Socio-Economic Survey, Calorie and Protein Consumption of the Indonesian Population in 2018. Jakarta.

Director General of Horticulture. 2018. Vegetable Production Data. Ministry of Agriculture. Jakarta. Accessed from http://hortikultura2.pertanian.go.id/produk/sayuran.php

Forney, C., Jordan, M., Campbell-Palmer, L., Fillmore, Sherry A. E., McRae, K. and Best, K.. (2010). Sulfur Fertilization Affects Onion Quality and Flavor Chemistry During Storage. ActaHorticulturae. 877. 163-168. 10.17660/ActaHortic.2010.877.14.

Hardjowigeno, S. 2010. Soil Science. Pressindo Academic. Jakarta

Havlin, J.L., J.P. Beaton., S.L. Tisdale and W.L. Nelson. 2016. Soil Fertility and Fertilizer. An Introduction to Nutrient Management. Eighth ed. Prentice Hall. New Jersey

Hendrawan, E. Arnis, and Isnaini. 2018. The Effect of Providing Water Hyacinth Compost and Planting Distance on the Growth and Production of Shallot Plants (*Allium ascalonicum* L.). JOM Faperta UR Vol. 5.

Herwanda, R., Murdiono, W. E., and Koesriharti, K. 2017. Application of Nitrogen and Foliar Fertilizer on the Growth and Yield of Shallot Plants (*Allium cepa* L. var. ascalonicum). Journal of Crop Production, 5(1).

Matamwa, W., Blair, G., Guppy, C., and Yunusa, I. 2018. Plant Availability of Sulfur Added to Finished Fertilizers. Communications in Soil Science and Plant Analysis, 49(4), 433-443.

National, Standardization Body. 2006. Organoleptic and/or sensory testing instructions. Jakarta: SNI:01-2346.

Nurhidayati, N., Basit, A., and Sunawan, S. 2013. Substitution of Ammonium Sulfate Fertilizer on Upland Sugarcane Cultivation and Its Effects on Plant Growth, Nutrient Content, and Soil Chemical Properties. AGRIVITA, Journal of Agricultural Science, 35(1), 36-43.

Pradhan, A. K. Pattnaik, P. Tripathy, K. Mallikarjunarao, B. B. Sahoo and J. Lenka.. 2015. Influence of Sulfur Fertilization on Nutrient Uptake Of Onion (Allium cepa L.). Journal Crop And Weed,. R. 134-138(2015). 10.13140/Rg.2.2.18676.37765.

Priska, M., Peni, N., Carvallo, L., &Ngapa, Y. D. (2018). Anthocyanins and their use. Cakra Kimia (Indonesian E-Journal of Applied Chemistry), 6(2), 79-97.

Puslittanak (Soil and Agroclimate Research Center). 2000. Indonesian Exploration Land Resources Atlas, scale 1:1,000,000. Puslittanak, Agricultural Research and Development Agency.

Sofyan, E. T. 2014. Effect of Sulfur Fertilizer with Bokashi Water Hyacinth (Eichorniacrassipes Mart. Solm) on pH, S-available, Fe Available, and Yield of Rice Plants (Oryza sativa L.) on Vertisols. Ziraa'ah Agricultural Scientific Magazine, 39(1), 17-25.

Sofyan, E. T. 2014. The Potential of Sulfur from Bokashi Water Hyacinth {*Eichhornia crassipes* (Martt.) solm} in Increasing the Quality and Yield of Rice on Inceptisols. Agrifor, 13(2), 165-174.

Sukasih, E., &Musadad, D. 2018. Physico-chemical characteristics of shallot New-Superior Varieties (NSV) from Indonesia. In IOP Conference Series: Earth and Environmental Science (Vol. 102, No. 1, p. 012037).
Sumarni, N. and Hidayat, A. 2005. Shallot Cultivation. Shallot PTT Technical Guide No.3. Vegetable Crops Research Institute: Bandung. ISBN: : 979-8304-49-7.
Supadma, A. N., Dana, I. M., and Arthagama, I. D. M. 2020. Increasing Shallot Yield and Changes in Soil Chemical Properties with Semi-Organic Balanced Fertilization in Inceptisol Soil. Agrotrope: Journal on Agricultural Science, 10(1), 67-76.
Suwandi, S. Gina and Yufdy, M. 2016. Effectiveness of Management of Organic Fertilizer, NPK, and Biological Fertilizer on the Growth and Yield of Shallots. Journal of Horticulture. 25. 208. 10.21082/jhort.v25n3.2015.p208-221.
Syamsuddin, A. B., and Hasrida, H. 2019. Empowering Shallot Farmers on the Welfare of Kolai Families, Enrekang Regency. Pulpit Journal of Social Welfare, 2(1). Empowerment of Shallot Farmers. journal.uin-alauddin.ac.id
Widodo, K. H., and Kusuma, Z. 2018. The effect of compost on soil physical properties and corn plant growth in Inceptisol. (JTSL) Journal of Soils and Land Resources, 5(2), 959-967.
Wulandari, D. A., Linda, R., and Turnip, M. 2016. Compost Quality from a Combination of Water Hyacinth (Eichorniacrassipes Mart. Solm) and Cow Manure with Trichodermaharzianum L. Protobiont, 5(2).
Yang, Zhi-Hui and Stöven, Kirsten and Haneklaus, Silvia and SINGH, B.R. and Schnug, Ewald. 2010. Elemental Sulfur Oxidation by Thiobacillus spp. and Aerobic Heterotrophic Sulfur-Oxidizing Bacteria. Pedosphere. 20. 71-79. 10.1016/S1002-0160(09)60284-8.

Comment [L3]: Additional references still need to be made, especially reputable journals