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Application of Nitrogen Fertilizer and Biofertilizer to Enhance the Growth and Yield of Shallots

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Abstract

Shallots are an essential vegetable commodity in Indonesia, valued for their numerous benefits. With the increasing population, the demand for shallots continues to rise each year, necessitating enhanced production through improved cultivation techniques, particularly in fertilization. The research aimed to identify the optimal doses of nitrogen fertilizer and biofertilizer to promote the growth and yield of shallots. The research employed a Complete Randomized Block Design (CRBD) with two treatment factors. The first factor consisted of nitrogen fertilizer at four levels: N1 (50 kg/ha), N2 (100 kg/ha), N3 (150 kg/ha), and N4 (200 kg/ha). The second factor involved biofertilizer at three levels: B1 (0 ml/l), B2 (5 ml/l), and B3 (10 ml/l). The parameters observed included plant height, number of leaves, number of tillers per plant, number of bulbs per plant, fresh weight of bulbs per plant, bulb diameter, leaf greenness level, and stomata density. The results indicated that there was no interaction between the nitrogen fertilizer doses and the concentrations of biofertilizer for any of the parameters measured. The optimal dose of nitrogen fertilizer was found to be 50 kg/ha, which significantly increased bulb diameter, fresh bulb weight, and the number of bulbs per plant. On the other hand, the application of biofertilizer showed no significant effect on any of the growth and yield parameters, with concentrations of up to 10 ml/l not yielding notable results.

Keywords: Shallots, nitrogen fertilizer, biofertilizer, growth, crop yield

Introduction

Shallots (*Allium cepa* var. *Aggregatum*) are an important horticultural commodity in the lives of the Indonesian people. They are utilized as food ingredients, spices, medicinal plants, and raw materials for industries with significant economic value. Shallot bulb contains important nutritive vegetable and medicinal (Mohammadi-Motlagh et al., 2011; Marlin et al., 2019). Shallot production is continually increasing to meet national demand. According to the Central Statistics Agency (BPS, 2022), Indonesia's shallot production was 1,815,445 tons in 2020, 2,004,590 tons in 2021, and 1,982,360 tons in 2022.

Indonesia should increase its shallot production, as a competitiveness study indicated that it is more profitable than importing shallots from other countries. One way to achieve this is by improving cultivation technology (Saptana et al., 2021). Conventional breeding methods face challenges in increasing the diversity of shallot genotypes, as not all shallot plants are capable of producing flowers (Marlin et al., 2018). To enhance productivity and yield quality, it is essential to provide shallot plants with sufficient and balanced macronutrients, particularly nitrogen, phosphorus, and potassium. Nitrogen, in particular, significantly impacts bulb production and quality (Amare, 2020). During the vegetative stage of growth, nitrogen is vital for the development of leaves, stems, and roots. It also plays a crucial role in the synthesis of chlorophyll in leaves. Chlorophyll is essential for absorbing light, which is necessary for synthesizing carbohydrates through photosynthesis, an important source of nourishment for the plant. The metabolic processes of plants heavily rely on the products of photosynthesis (Marschner, 2011).

Shallot plants fertilized with nitrogen at the appropriate rate can produce more and larger bulbs. High fresh weight of bulbs and biomass in the Mesuji area requires water at least 75% ETc and N fertilizer doses of 160 kg N ha^{-1} (Manik et al. 2023). Increased rates of N fertilizer up to 200 kg N ha^{-1} significantly increased bulb diameter (31.03%), fresh bulb weight (48.57%), and dry weight (35.95%) of either the seeds that came from true seed shallot variety or bulb-propagated shallots (Buda et al., 2018).

Agriculture in Indonesia is generally very dependent on the use of inorganic fertilizers. This is because inorganic fertilizers can provide nutrients needed by plants quickly, so that they can increase agricultural production quickly. However, the continuous use of inorganic fertilizers will cause changes in soil structure, soil compaction, decreased soil nutrient content, and environmental pollution, which results in decreased land productivity. One effort to increase plant productivity without reducing soil productivity is to use inorganic fertilizers balanced with organic fertilizers, such as a combination of fertilization between nitrogen fertilizers and biofertilizers.

Bioboost is a biofertilizer that contains microorganisms that are very useful in the decomposition process of organic materials, such as *Azotobacter*, *Azospirillum*, *Bacillus sp.*, *Pseudomonas sp*., and *Cytophaga sp*. Bioboost also contains hormones such as gibberellin, cytokinin, kinetin, zeatin, and auxin (IAA). The use of Bioboost can reduce the use of inorganic fertilizers by 50% to 60%, bind free N in the root zone, accelerate the biochemical process of the soil that produces P and K available to plants that can increase soil fertility and accelerate the harvest time that can meet standards (Manuhuttu, 2014).

The interaction between shallots of local varieties with the provision of Bioboost fertilizer showed there was no significant effect at the age of 3 and 5 weeks after planting, but had a significant effect on plant height at the age of 7 and 9 weeks after planting (Lubis, 2017). The results of the study by Zamriyetti and Siregar (2018) showed that the highest total chlorophyll in the study of shallot plants was found at a bioboost concentration of 8 ml / L with rice husk charcoal and cocopeat media 1: 1. The purpose of this study was to determine the dose of nitrogen fertilizer and the best concentration of biofertilizer that can increase the growth and yield of shallots.

Research Method

This research was conducted from June to August 2021 at an experimental field in Bengkulu City with an altitude of 15 meters above sea level. The materials used in this study were Ilokos variety shallot seeds, soil, rice husk charcoal, raw rice husks, bioboost biofertilizer, urea fertilizer, KCl, SP36, fungicide with 70% propinep active ingredient and 80% mancozeb active ingredient, insecticide with 3% carbofuran active ingredient, water, and polybags. The equipment used in this study included hoes, rulers, digital scales, digital calipers, samples, hand sprayers, calculators, SPAD Meters, microscopes, and stationery.

The design used in this study was a Complete Randomized Block Design consisting of 2 treatment factors and three replications. The first factor was the dose of nitrogen fertilizer (N), composed of 4 levels, namely 50 kg/ha (N1), 100 kg/ha (N2), 150 kg/ha (N3), and 200 kg/ha (N4). The second factor was the concentration of Bioboost organic fertilizer (B) with three levels, namely 0 ml/l (B1), 5 ml/l (B2), and 10 ml/l (B3). Planting media is prepared by mixing Ultisol soil, rice husk charcoal, and raw rice husk in a ratio of 2:1:1. The polybags are arranged with a spacing of 30 cm by 20 cm. To promote faster shoot growth, shallot seedlings are prepared by cutting off one-third of the top of each seedling and then applying a fungicide. When planting, half of each bulb is immersed in the planting medium within the polybag, with a planting distance of 10 cm by 10 cm. Each polybag should contain two bulbs. The application of biofertilizer occurs three times: at 3, 21, and 35 days after planting (DAP). Nitrogen fertilizer is applied three times as well, at 4, 22, and 36 DAP. Maintenance includes daily irrigation in the afternoon, adjusted according to soil conditions. The basic fertilizers used are SP-36 and KCl, each applied at a dose of 100 kg/ha (or 1.67 g per plant). Harvesting takes place at 69 HST days after planting, when the leaves turn yellow and droop, some bulbs emerge on the soil surface, and the bulb layer appears red.

Observation variables in this research were plant height (cm), number of leaves, number of tillers per plant, number of bulbs per plant, fresh weight of bulbs per plant (g), bulb diameter (mm), leaf greenness level (nm), and stomatal density (µm). The research data were analyzed using the F test at the 1% level. If there was a real or very real effect, further testing was carried out using Orthogonal Polynomials.

Results and Discussion

During the three months of the study (June–August), the weather was unpredictable, featuring a mix of heat, rain, and strong winds. The average monthly rainfall was recorded at 388.9 mm, 259 mm, and 282.4 mm, which exceeded the optimal requirement for shallots of only 100–200 mm per month. Sunlight levels were measured at 79.90%, 78.23%, and 53.45%, while air humidity averaged 83.83%, 82.77%, and 84.65%. The air temperature ranged from 26.73°C to 26.95°C (BMKG, 2021). It is believed that the high rainfall adversely affected the growth and production of shallots (Masroni et al., 2023). Soil conditions for the study were analyzed and found to be acidic, with a pH value of 5.4. The nutrient content in the soil was as follows: organic carbon at 3.01%, nitrogen at 0.26%, phosphorus at 2.46 ppm, and potassium at 0.26 me/100 g.

During the research, several attacks by shallot caterpillar pests were observed on shallot plants. The symptoms included translucent leaves that eventually drooped. Additionally, the plants were affected by Fusarium wilt disease two weeks after planting (WAP) and auto/anthracnose disease at 4 WAP. Root neck rot disease emerged when the plants reached 6 WAP.

Analysis of Variance of the Effect of Nitrogen Fertilizer and Biofertilizer Doses on the Growth and Yield of Shallots.

The data obtained were analyzed using analysis of variance. Normality tests were carried out on the observation variables of stomata density, bulb diameter, fresh bulb weight, and number of bulbs. The data obtained were not homogeneous, so data transformation was carried out using the √(x+1) method.

Table 1. Summary of the results of the analysis of variance for the growth and yield of shallots.

No	Variable	F-value			Coefficient of Varians (%)
		Interaction	Dose of Nitrogen	Concentration of Biofertilizer	
1	Plant height	0,41 ns	3,93 *	1,09 ns	18,31
2	Number of leaves	0,75 ns	0,98 ns	1,52 ns	28,25
3	Number of tillers	1,36 ns	1,56 ns	0,42 ns	27,54
4	Leaf greenness level	0,74 ns	0,43 ns	0,07 ns	23,47
5	Stomatal density ^{t}	0,90 ns	1,73 ns	1,69 ns	3,9
6	Bulb diameter ^{t}	0,65 ns	13,15**	0,11 ns	26,87
7	Bulb fresh weight ^{t}	1,13 ns	10,64**	0,09 ns	14,44
8	Number of bulb ^{t}	1,09 ns	11,65**	0,37 ns	13,27

note : ns= non significantly different effect, * = significantly different effect, **= High significantly different effect of analisis varians, ^{t} = Transformation data with $\sqrt{x+1}$

Table 1 demonstrates that the nitrogen fertilizer dosage had a significantly different effect on plant height 9 WAP, and has a very significantly different effect on bulb diameter, bulb fresh weight, and the number of bulbs. In contrast, the concentration of biofertilizer does not have a significant effect on any of the observed variables.

Effect of Interaction between Nitrogen Fertilizer Dose and Biofertilizer Concentration on Shallot Growth and Yield

Interaction is a process that occurs when two factors influence or impact each other. The results of the variance analysis showed that there was no interaction between nitrogen fertilizer treatment and biofertilizer on all observation variables of shallot plants, meaning that nitrogen fertilizer treatment and biofertilizer gave their responses without being influenced by other treatments. The average values of plant height, number of leaves, number of tillers, leaf greenness, stomata density, bulb diameter, fresh bulb weight, and number of bulbs were presented in Table 2.

Table 2. Effect of nitrogen fertilizer dosage and biofertilizer concentration on shallot growth and yield.

Treatment	PH (cm)	NL	NT	SD (µm)	LG (nm)	NB	BFW (g)	BD (mm)
N_1B_1	13,72	13,00	3,34	1,14	38,27	0,92	1,06	3,67
N_1B_2	14,33	7,46	1,83	1,14	34,95	1,08	1,19	4,16
N_1B_3	12,93	11,27	3,07	1,24	41,80	1,25	1,39	4,01
N_2B_1	14,81	12,28	3,04	1,15	35,75	0,08	0,13	0,81
N_2B_2	14,70	12,57	3,24	1,15	39,70	0,83	0,70	1,44
N_2B_3	14,68	12,73	3,66	1,15	33,10	0,42	0,72	1,74
N_3B_1	13,46	11,80	3,41	1,16	28,42	0,08	0,13	0,80
N_3B_2	12,88	11,86	3,11	1,12	37,08	0,08	0,23	0,76
N_3B_3	13,26	12,60	2,56	1,15	36,15	0,00	0,00	0,00
N_4B_1	14,23	12,41	3,14	1,14	38,80	0,33	0,53	1,51
N_4B_2	13,33	11,67	3,34	1,15	34,65	0,00	0,00	0,00
N_4B_3	13,92	13,56	3,21	1,14	32,95	0,00	0,00	0,00

Note : PH (plant height), NL (number of leaves), NT (number of tiller), SD (stomatal density), LG (leaves greenness level), NB (number of bulb), BFW (bulb fresh weight), BD (bulb diameter)

The plant height obtained due to the administration of nitrogen fertilizer doses and biofertilizer concentrations ranged from 12.88 to 14.81 cm. The variable number of leaves ranged from 7.46 to 13.56 strands. The number of tillers ranged from 1.83 to 3.66 tillers. Stomata density ranged from 1.12 to 1.24 µm. The number of bulbs ranged from 0 to 1.25 bulbs. The level of leaf greenness ranged from 28.42 to 41.80 nm. The variable fresh plant weight ranged from 0 to 1.39 grams. The variable bulb diameter ranged from 0 to 4.16 mm (Table 2).

The interaction between nitrogen fertilizer and biofertilizer treatments had no significant effect on all observation variables. It is possible that there was no interaction because each treatment worked more dominantly than the interaction between the two factors. This proves that the two treatment factors responded as a single factor without any interaction between the two factors (Tiurmaida, 2016). Tenaya (2015) stated that if the interaction had no significant effect, then the combined factors worked freely or their effects stood alone.

The Effect of Nitrogen Fertilizer Dose on the Growth and Yield of Shallots

Plant growth is influenced by several factors, namely internal factors and external factors. The provision of nitrogen fertilizer is an external factor that affects plant height. The response of the provision of nitrogen fertilizer doses on plant height forms a linear curve.

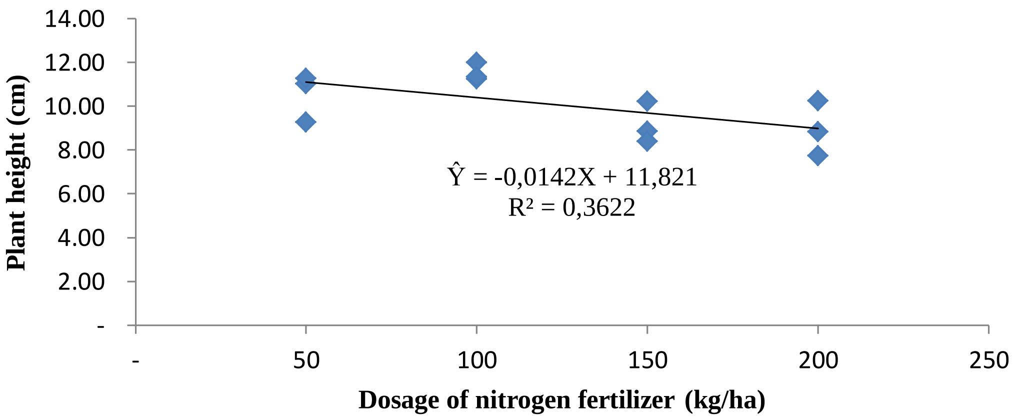

Figure 1. Effect of nitrogen fertilizer dose on the plant height of shallot

The orthogonal polynomial test showed that the relationship between nitrogen fertilizer dose and plant height 9 WAP formed a negative linear curve pattern. The reaction shown illustrates that the higher the dose of nitrogen fertilizer, the lower the height of the 9 WAP plant. The plant height was influenced by the administration of nitrogen fertilizer doses with a coefficient of determination (R2) of 36%. The decrease in the growth rate of shallots in the treatment of decreasing N fertilizer doses is because at that level, the amount of nutrients given is excessive, thus suppressing the rate of plant growth. Niu et. al. (2024) stated that excessive N administration can inhibit plant height growth and cause ammonium poisoning. High nitrogen conditions in acidic red soil areas directly affect plant growth and development.

The application of higher doses of nitrogen fertilizer at 9 WAP resulted in a decrease in the height of shallot plants. This phenomenon is believed to be linked to the acidic soil pH conditions (pH 5.0), which can be affected by nitrogen fertilizer. According to Aryanti et al. (2016), an increase in soil pH will reduce the solubility of H+ ions. Consequently, the amount of exchangeable H+ gradually decreases, leading to a reduction in dissolved H+ ions. These H+ ions are then neutralized by OH− ions generated from the hydrolysis of base cations derived from organic matter. Additionally, some exchangeable H+ ions are ionized to maintain the system's balance. The application of nitrogen fertilizer also influences the bulb diameter, bulb fresh weight, and the number of bulbs produced. The response of these variables to different doses of nitrogen fertilizer forms a quadratic curve.

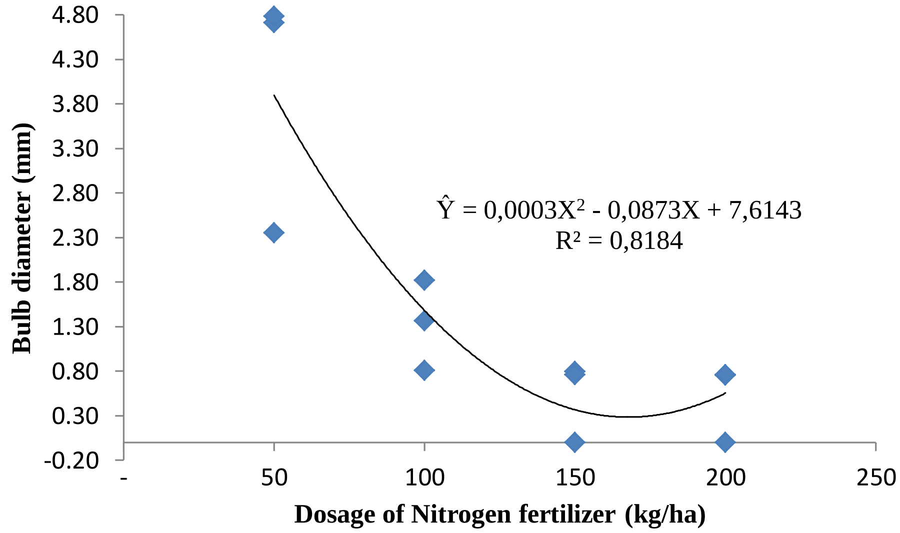

Figure 2. Effect of nitrogen fertilizer dose on the bulb diameter of shallot plants

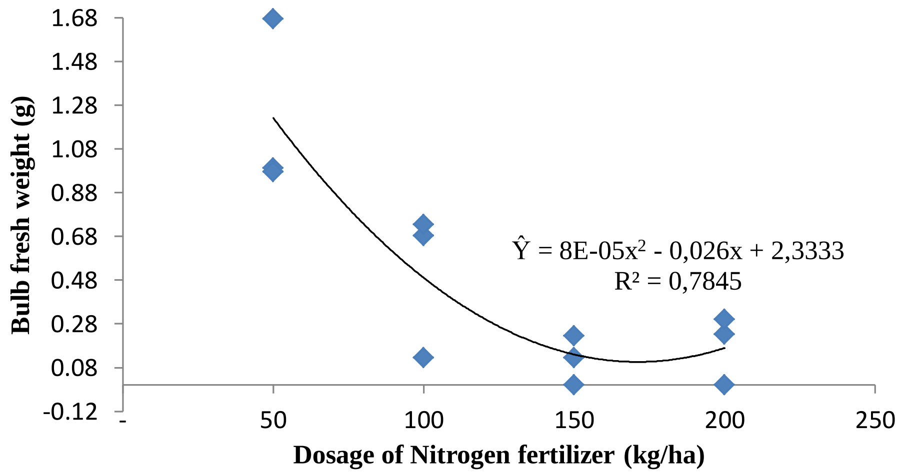

Figure 3. Effect of nitrogen fertilizer dose on bulb fresh weight of shallot plants

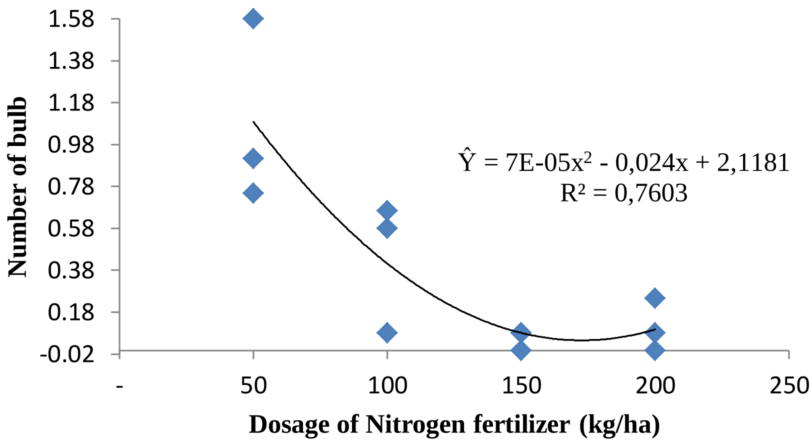

Figure 4. Effect of nitrogen fertilizer dose on the bulb number of shallot plants

Orthogonal polynomial test showed that the response of bulb diameter, fresh bulb weight and number of bulbs to the dose of nitrogen fertilizer formed a quadratic curve with bulb diameter equation line $\hat{Y} = 0.0003X2 - 0.0873X + 7.6143$ ($R^2 = 0.8184$), fresh bulb weight with equation line $\hat{Y} = 0.00008X2 - 0.026X + 2.3333$ ($R^2 = 0.78$), number of bulbs with $\hat{Y} = 0.00007X2 - 0.024X + 2.1181$ ($R^2 = 0.76$). The application of nitrogen fertilizer with different doses to the diameter of the bulb, fresh bulb weight, and number of shallot bulbs formed a negative quadratic curve pattern. The response of bulb diameter, fresh bulb weight, and number of bulbs to the dose carried out showed that the highest dose absorption was found in the application of nitrogen fertilizer of 50 kg/ha. Based on the curve above, it can be seen that the administration of nitrogen fertilizer with a dose of 50 kg/ha is the highest concentration that produces the largest bulb diameter, namely 4.8 mm, the heaviest fresh bulb weight, namely 1.68 g, and the largest number of bulbs, namely 1.58 bulbs.

The determination values of R^2 for bulb diameter, fresh bulb weight, and the number of bulbs are 0.81, 0.78, and 0.76, respectively. This indicates that 81% of the variation in bulb diameter was affected by nitrogen fertilizer, 78% of fresh bulb weight was affected by nitrogen fertilizer, and 76% of the number of bulbs was affected by nitrogen fertilizer. The remaining 19%, 22%, and 24% of these characteristics are affected by natural factors, particularly high rainfall, pest and disease attacks on shallot plants, poor soil nutrient content, and acidic soil pH.

During the research, the soil pH decreased from an initial value of 5.4 to 5.0 by the end of the study. This decline in soil pH was attributed to the application of urea, which can lower pH levels. Urea contains ammonia, which is converted into nitrate through a process known as nitrification (Pogon et al., 2023). The nitrification process produces hydrogen ions, leading to an increase in soil acidity (Nuraini and Zahro, 2020). The availability of sufficient nutrients positively influences bulb growth, as nitrogen (N) is absorbed by plants throughout their growth period until ripening (Wulandari et al., 2016). Soil pH values can serve as indicators of microbial activity within the soil, which in turn affects nutrient availability for plant growth (Susilawati and Maftuah, 2016). When pH conditions are not ideal, nutrient absorption can become less efficient, resulting in the development of smaller bulbs.

Consclusion

The conclusion of the research that has been conducted is as follows:

1) There is no interaction between the dose of nitrogen fertilizer and the concentration of biofertilizer on all parameters of growth and yield of shallots.
2) The highest absorption of nitrogen fertilizer dose on bulb diameter, fresh weight of bulbs, and number of bulbs of shallots is 50 kg/ha.
3) The best concentration of biofertilizer for the growth and yield of shallots was not obtained. The provision of biofertilizer concentration up to 10 ml/l did not significantly affect all parameters of growth and yield of shallots.

References

Lubis, R.A. (2017). Some Tests of Variety And Growing of Biobost Fertilizers on Growth and Production of Shallot (*Allium ascolonicum* L.). *Jurnal BioLink*, 3(2) : 112.

Amare, G. (2020). Review on mineral nutrition of shallot (*Allium cepa* L). *The Open Biotechnology Journal*, *14*(1).

Aryanti, E., Novlina, H., Saragih, R. 2016. Effect of Azolla pinnata compost with different dose for macro fertility of Peat soil and it's application in plant growth (*Ipomea reptans poir*). Jurnal Agroteknologi 6(2), 31-38. http://dx.doi.org/10.24014/ja.v6i2.2238.

Badan Pusat Statistik. (2019). Produksi Tanaman Sayuran. https://www.bps.go.id. Retrieved at October 23 2020.

Berlian dan Rahayu. (2004). Shallot recognize superior varieties and continuous cultivation methods. Penebar Swadaya. Jakarta.

Buda, I. S., Igams, A., & Ipg, A. (2018). Nitrogen Fertilizer Increased Bulb Diameter and Yields of True Seed and Bulb – propagated Shallot Varieties. International Journal of Innovative Research in Science, Engineering and Technology, 7(1), 80-86.

Damanik, M. M. B. D., Hasibuan, B. E., Fauzi, Sarifuddin, dan Hamidah, H. (2011). Soil fertility and fertilization.USU Press, Medan.

Firmansyah, I., dan Sumarni, N. (2013). Effect of N Fertilizer Dosages and Varieties On Soil pH, Soil Total-N, N Uptake, and Yield of Shallots (Allium ascalonicum L.) Varieties On Entisols-Brebes Central Java. *J. Hort*. 23(4):358-364.

Foth, H. D. (1995). Fundamentals of soil science. Translated by Purbayanti, ED, Lukiwati & Trimulatsih. Gadjah Mada University Press, Yogyakarta.

Gardner, F. K., Pearce, B., dan Mitchell, R. (1995). Charge symmetry breaking potentials from isospin-violating meson-baryon coupling constants. *Physical review letters*, 75(13):24-62.

Harjadi, S. (1988). Introduction to Agronomy. PT. Gramedia. Jakarta.

Juwanda, M. (2011). Growth, yield and efficiency of nitrogen fertilization of shallot plants by administering doses of nitrogen fertilizer and cow manure. Tesis. Fakultas Pertanian, UNSOED, Jawa Tengah.

Manik, T.K., Paul, B.T., and Mua'ddin (2023). Shallot growth and yield supported by irrigation and nitrogen application in utilizing dry land area in Mesuji, Lampung Province, Indonesia. Sains Tanah Journal of Soil Science and Agroclimatology, 20(1): 100-113. https://dx.doi.org/10.20961/stjssa.v20i1.70711.

Manuhuttu, A. P., Rehatta, H., dan Kailola, J. J. G.. (2014). The effect of bioboost organic fertilizer concentration on increasing lettuce (*Lactuca sativa* L) plant production. *Agrologia Jurnal Ilmu Budidaya Tanaman*, 3, (1).

Marlin, Maharijaya, A., Purwito, A., Sobir. 2018. Molecular diversity of the flowering related gene (*LEAFY*) on shallot (*Allium cepa* var. *aggregatum*) and *allium* relatives. *SABRAO Journal of Breeding and Genetics.* 50 (3), 313-328

Marlin, M., Maharijaya, A., Purwito, A., Sobir, S. 2019. Secondary metabolites change under Vernalization and its relation to flowering Competency in shallot (*Allium cepa* var. *aggregatum*). *Rasayan Journal of Chemistry* 12(3): 1418-1425. **Doi:** http://rasayanjournal.co.in/admin/php/upload/724_pdf.pdf

Marschner P 2011 Marschner's mineral nutrition of higher plants. (London:Academic Press).

Masroni, Kristina A., Sholeha A., (2023). Analysis of factors influencing shallot production in Sengon Village, Tanjung District, Brebes Regency. *JECMER: JournalofEconomic,ManagementandEntrepreneurshipResearch*, 1(2): 11-20.

Niu, R., Zhuang, Y., Lali, M. N., Zhao, L., Xie, J., Xiong, H., Wang, Y., He, X., Shi, X., dan Zhang, Y. (2024). Root reduction caused directly or indirectly by high application of nitrogen fertilizer was the main cause of the decline in biomass and nitrogen accumulation in citrus seedlings. *Plants*, 13(938): 1-15. doi: https://doi.org/10.3390/plants13070938.

Nuraini, Y., dan Zahro, A. (2020). The effect of application of humic acid and NPK fertilizer on nitrogen absorption of rice plant growth in rice fields. *Jurnal Tanah dan Sumberdaya Lahan*, 7(2), 195–200. https://doi.org/10.21776/ub.jtsl.2020.007.2.2.

Nyanjang, R., Salim, A. A., Rahmiati, Y. (2003). The use of NPK 25-7-7 compound fertilizer to increase the quality of tea production in Andisols soil. Prosiding Teh Nasional. PT. Perkebunan Nusantara XII. Gambung. Hal 181- 185.

Patti, P. S., Kaya, E., dan Silahooy Ch. (2013). Analysis of soil nitrogen status in relation to N absorption by paddy plants in Waimital Village, Kairatu District, West Seram Regency. *Agrologia*, 2(1) : 51-58.

Pogon, T. Y., Putra, D. P., dan Rusmarini, U., K. (2023). Effectiveness of nitrogen nutrient absorption in sugarcane (*Saccharum officinarum* L) seedlings. *Journal of Agribusiness and Agrotechnology*, 4(2): 53-57.

Saptana, Gunawan, E., Perwita, A. D., Sukmaya, S. G., Darwis, V., Ariningsih, E., & Ashari. (2021). The competitiveness analysis of shallot in Indonesia: A Policy Analysis Matrix. PLOS ONE, 16(9), e0256832. https://doi.org/10.1371/journal.pone.0256832

Singh, S. P., and Verma, A. B. (2001). Response of shallot (*Allium cepa*) to potassium Application. *Indian Journal of Agronomy*, 46: 182-185.

Susilawati, A., dan Maftuah, E. (2016). Technology of utilization and fertilization of soybean plants on degraded acid sulfate land. Balai Penelitian Pertanian Lahan Rawa (BALITTRA). Banjarbaru.

Syarief, S. (1986). *Fertility and fertilization of agricultural land*. Pustaka Buana, Bandung**.**

Tenaya, I. M. N. (2015). The effect of interaction and interaction value on factorial experiments. *AGROTROP*, 5 (1): 9-15.

Tiurmaida, Romaida, A., dan Suharjo, U. K. J. (2016). Growth and yield responses of bawang Dayak (*Eleutherine palmifolia* L.) to several types and concentrations of foliar fertilizer. Skripsi. Universitas Bengkulu, Bengkulu.

Waluyo, N. dan Sinaga, R. (2015). Shallots released by vegetable research institute. *J. Balitsa Litbang Pertanian*, (5): 1.

Wulandari, W., Idwar dan Murniati. (2016). The effect of organic fertilizer in increasing the efficiency of nitrogen fertilizer for the growth and production of shallots (*Allium Ascalonicum* L.). *JOM FAPERTA*, 3(2)

Zamriyetti, Siregar, M. (2018). Response of Bioboost fertilizer and several types of planting media on the growth and production of shallots (Allium cepa L.) in the wick hydroponic planting system. *Journal of animal science and agronomy panca budi*, 3(1):58.

Zhang, Y., Yu, S., Chang, T., Qicong. (2022). Effects of excessive nitrogen fertilizer and soil moisture deficiency on antioxidant enzyme system and osmotic adjustment in tomato seedlings. *Int. J. Agric & Biol. Eng*, 15(2): 127-134. doi:: 10.25165/j.ijabe.20221502.5555.