AN EXPERIMENT TO DETERMINE THE OPTIMAL VALUE OF ORGANIC FERTILIZER AND BIOCHAR TO INCREASE PRODUCTIVITY OF SHALLOTS VAR. BATU IJO

Endang Kantikowati[1]*, Karya[1], Yudi Yusdian[1], Dian Murti Minangsih[1], Abdul Aziz Nurjaman[1]
[1]Faculty of Agriculture, Universitas Bale Bandung, Bandung 40375, Indonesia
*Correspondence: endangkantikowati99@gmail.com

ABSTRACT

The experiment aimed to assess the characteristics of growth and yield of shallots due to the application of organic fertilizer and biochar and to obtain an optimal dose that can give the best effect. The research began in July and continued until September 2021. It was conducted to test the use of organic fertilizer and biochar to increase shallot productivity in the field. The experiment was arranged as a factorial randomized block design with three replications. The first factor was organic fertilizers (0, 5, and 10 tons.ha^{-1}), while the second factor was biochar (0, 7.5, and 15 kg.ha^{-1}). Statistical tests used the Anova and Duncan Multiple Range Test (DMRT) at the 5% significant level. The parameters observed included the growth component and yield component of shallots, i.e., plant height, number of leaves, number of tillers, number of bulbs, weight average of bulbs, and bulbs weight per plot. The results showed that the application of organic fertilizer at a dose of 10 tons.ha^{-1} and biochar at a dose of 15 kg.ha^{-1} gave a better effect on plant height, number of leaves, number of tillers, number of bulbs, weight average of bulbs and bulbs weight per plot.

Keywords: batu ijo variety; biochar; organic fertilizer; shallots; yield

Submitted : 11 October 2023
Accepted : 1 May 2024
Published : 15 May 2024

INTRODUCTION

Shallot (Allium cepa L.) is a vegetable commodity that farmers have cultivated for a long time. The community's need for shallots will continue to increase along with the increase in population. This commodity is a relatively high-income source for regional economic development in Indonesia (Dyah & Putra, 2021). As a horticultural commodity widely consumed by the public, the potential for shallot development is still wide open for domestic and foreign needs (Saptana et al., 2021). This is a potential opportunity, so the availability of shallot commodities must always be maintained.

Based on Table 1, the land area, production, and productivity of shallots in Indonesia in the last six years have fluctuated. In 2014, shallot production was 1,233,984 tons; in 2015, it decreased by 4,800 tons. In 2016, there was an increase of 217,676 tons, and in 2017, 2018, and 2019, there was an increase in production. The area of shallot fields in Indonesia has fluctuated with an increasing trend. Although the increase in land area is in line with production, productivity has declined over the last four years (2015 – 2019). The highest productivity was achieved in 2014 when the land area was narrower than in 2015 – 2019.

Due to population growth, the need for shallots is increasing public awareness of nutrition and expanding utilization of shallot production for various foodstuffs, both as vegetables and snacks. The government adopted a policy of importing shallots from abroad, even though this will result in less demand for domestic production (Prabawati et al., 2018). Thus, the productivity and quality of shallots need to be increased to meet domestic demand.

Some of the problems encountered in shallot cultivation include (1) the availability of quality seeds is not optimally sufficient; (2) the application of cultivation techniques has not been carried out optimally; (3) facilities and infrastructure are still limited; (4) productivity tends to decrease (Suswadi et al., 2021; Hasanah et al., 2022; Napitupulu et al., 2021). These problems affect the quality and quantity of shallot crop production.

One effort to increase shallot production is using organic materials such as chicken manure, which contains macro and micronutrients. Chicken manure, as one of the organic fertilizers, consisted of N 1.0%, P 0.80%, and K 0.40% higher than cow manure (N 0.4%, P 0.2%, K 0.10%), and goat manure (N 0.60%, P 0.30%, K 0.17%) (Setiawan, 2010). These nutrients are used for plant growth and development. Manure application can improve soil physical properties, water holding capacity, soil mass density, and total porosity, improve soil aggregate stability, increase soil humus content, and increase soil fertility (Mukai, 2018).

The purpose of adding biochar to the planting medium is to improve the soil's physical, chemical, and biological properties. The composition contained in the biochar can optimize plant growth. The ability of biochar can retain moisture, so it helps plants during drought periods and acts as a plant growth booster, as well as retaining nutrients in the soil so that nutrients in the soil are not easily lost (leaching), which will affect increased crop yields (Agegnehu et al., 2017). According to Ding et al. (2016), biochar can improve soil conditions and increase crop production, especially in infertile soils. Biochar is an organic material that is useful for improving soil structure.

Using biochar is a prospective agricultural waste management effort that encourages the optimization of suboptimal and degraded lands (Nurida, 2014). Moreover, the application of biochar to agricultural soil promotes the fertility of the soil, along with increasing the productivity of crops. Biochar also improves nutrient and water use efficiency (Ali et al., 2019). According to Turmuktini et al. (2020), biochar used in the experiment contains compost (40%), Biochar (20%), Dolomite (20%), humic acid (5%), guano (4%), KCl (3%), additives (5%), and biofertilizer (3%).

Table 1. Data on Area, Production, and Productivity of Shallot in Indonesia from 2014 –2019

Year	Area (ha)	Production (Ton)	Productivity (Ton/ha)
2014	90,912	1,233,984	13.57
2015	122,126	1,229,184	10.06
2016	149,635	1,446,860	9.67
2017	158,172	1,470,155	9.29
2018	156,779	1,503,436	9.59
2019	159,195	1,580,247	9.92

Source: Central Bureau of Statistics and Directorate General of Horticulture, (2020)

MATERIALS AND METHODS

The experiment was conducted in Cikalong Village, Cimaung District, Bandung Regency, West Java Province. The trial time is from July to September 2021. The altitude is 995 m above sea level, with a maximum temperature of 35° Celsius, a minimum temperature of 20° Celsius, and rainfall of 2354.2 mm/year, including type C3 rainfall according to Oldeman classification.

The materials used in this experiment were green onion seeds, chicken manure, biochar, and pesticides (Insecticide et al. 80 WP). The tools used in this experiment were hoes, knives, hammers, tape measure, markers, stationery, sprayers, and other tools that support research.

The research method used a randomized block design (RBD) with two factors. The first factor was the chicken manure (K), which consisted of 3 levels of treatment, namely 0 tons, ha^{-1} (k1), and 5 $tons.ha^{-1}$ (k2), and 10 $tons.ha^{-1}$ (k3). The second factor was the dose of Biochar (H), which consisted of 3 treatment levels, namely: 0 $kg.ha^{-1}$ (h1), 7.5 $kg.ha^{-1}$ (h2), and 15 $kg.ha^{-1}$ (h3). Data were analyzed using ANOVA and Duncan's Multiple Range Test (DMRT) at a significant level of 5%.

The experiment was conducted on a field with a 240 cm x 120 cm plot size of 27 plots (one plot consisted of 216 plants). Plant spacing is arranged by 20 cm x 30 cm. Chicken manure and biochar were applied before planting. The number of samples was four plants randomly.

The growth and yield characteristics that were observed were plant height, number of leaves, number of tillers, number of bulbs, weight average of bulbs, and bulbs weight per plot. Plant height was measured using a ruler from the stem's base to the leaf's tip at 28, 42, and 56 days after planting (DAP). The number of leaves was counted from all tillers at 28, 42, and 56 DAP. The tillers were counted based on the tillers producing leaf at 70 DAP. The number of bulbs is counted per plant at harvest. The weight of the bulb was measured using analytical scales at harvest. It was previously dried under the sun for two days.

RESULTS AND DISCUSSION

Results

The main observations were the components of plant growth and yield components of shallot plants. All variables/responses were analyzed statistically. The analysis results are as follows: Plant Height (cm). The parameter of shallot plant height was measured at the age of 28, 42, and 56 days after planting (DAP). The average height of shallot plants in various treatments is presented in Table 2. It can be seen that the effect of various doses of chicken manure 10 tons/ha and the treatment of doses biochar 15 kg/ha gave a better effect and was significantly different compared to other treatments in observations 28, 42, and 56 DAP to the average plant height.

Table 3 shows that the doses of chicken manure and biochar in each observation showed that the application of 10 tons/ha of chicken manure and 15 $kg.ha^{-1}$ of biochar increased the number of leaves more than other treatments. In Table 4, the effect of the treatment of chicken manure and biochar doses shows that the application of 10 tons/ha of chicken manure and 15 $kg.ha^{-1}$ of biochar can increase the number of tillers, significantly different from other treatments.

Table 2. Effect of Treatment of Chicken Manure Dosage and Biochar Dosage on Plant Height at 28, 42, and 56 DAP

Treatments	Plant Height (cm)		
	28 DAP	42 DAP	56 DAP
Chicken manure			
k1 (0 $ton.ha^{-1}$)	27.75 a	33.50 a	36.08 a
k2 (5 $tons.ha^{-1}$)	36.22 b	40.19 b	45.58 b
k3 (10 $tons.ha^{-1}$)	44.75 c	47.28 c	53.92 c
Biochar			
h1 (0 $kg.ha^{-1}$)	33.44 a	38.06 a	42.33 a
h2 (7.5 $kg.ha^{-1}$)	36.17 b	40.39 b	45.25 b
h3 (15 $kg.ha^{-1}$)	39.11 c	42.53 c	48.00 c

Notes: The average number marked with the same letter in the same column differed significantly accordingto Duncan's Multiple Range Test at a 5% significance level.

Table 3. Effect of Treatment of Chicken Manure Dosage and Biochar Dosage on Number of Leaves at 28, 42, and 56 DAP

Treatments	Number of Leaves		
	28 DAP	42 DAP	56 DAP
Chicken manure			
k1 (0 $ton.ha^{-1}$)	21.36 a	28.53 a	29.42 a
k2 (5 $tons.ha^{-1}$)	30.31 b	37.50 b	37.36 b
k3 (10 $tons.ha^{-1}$)	39.44 c	46.19 c	46.06 c
Biochar			
h1 (0 $kg.ha^{-1}$)	27.50 a	34.39 a	34.61 a
h2 (7.5 $kg.ha^{-1}$)	30.33 b	37.61 b	37.64 b
h3 (15 $kg.ha^{-1}$)	33.28 c	40.22 c	40.58 c

Notes: The average number marked with the same letter in the same column differed significantly accordingto Duncan's Multiple Range Test at a 5% significance level.

Table 4. Effect of Treatment of Chicken Manure Dosage and Biochar Dosage on Number of Tillers, Number of Bulbs, Weight of Bulbs per Plant, and Weight of Bulbs per Plot

Treatments	Number of Tillers	Number of Bulbs	Weight of Bulbs per Plant (g)	Weight of Bulbs per Plot (kg)
Chicken manure				
k1 (0 $ton.ha^{-1}$)	9.78 a	11.42 a	40.16 a	4.47 a
k2 (5 $tons.ha^{-1}$)	12.61 b	14.28 b	46.44 b	7.48 b
k3 (10 $tons.ha^{-1}$)	15.56 c	17.22 c	52.53 c	10.58 c
Biochar				
h1 (0 $kg.ha^{-1}$)	11.75 a	13.42 a	44.36 a	6.49 a
h2 (7.5 $kg.ha^{-1}$)	12.53 b	14.22 b	46.53 ab	7.60 b
h3 (15 $kg.ha^{-1}$)	13.67 c	15.28 c	48.25 c	8.54 c

Notes: The average number marked with the same letter in the same column differed significantly accordingto Duncan's Multiple Range Test at a 5% significance level.

In Table 4, it can be seen that there was no interaction between the treatment of chicken manure and biochar doses. The single effect of the dose treatment of chicken manure k3 (10 $kg.ha^{-1}$) and biochar h3 (15 $kg.ha^{-1}$) had a good effect and significantly differed from other dose treatments. Based on the results, the average number of clumping bulbs in shallot plants with biochar was highest in the h3 treatment (15 kg/ha), while the lowest was in the h1 dose (0 kg/ha).

In Table 4, the dose treatment of chicken manure showed that the treatment dose of 10 tons/ha gave a better effect and significantly differed from the treatment with a dose of 0 tons/ha and a dose of 5 tons/ha. The dose treatment of chicken manure showed that the treatment dose was 10 $tons.ha^{-1}$ gave a better effect and significantly differed from the treatment dose of 0 tons/ha and 5 $tons.ha^{-1}$ (Table 4). Likewise, the biochar dose treatment showed that the 15 kg/ha dose treatment had a better effect and significantly differed from other treatments.

Discussion

Biotic and abiotic factors influence plant vegetative growth. According to Boldea et al. (2015), fertilizer application must be in the right amount to obtain optimal yield. Growth, defined as the increase in plant weight and size due to the formation of new structural elements, is strongly influenced by the availability of nutrients and the activity of microorganisms in the soil.According to Wan et al. (2020), the activity of microorganisms in decomposing chicken manure is influenced by the diversity and number of populations. The addition of chicken manure to the soil, in addition to increasing the number and activity of soil microorganisms, can also provide nutrients for plants, increase humus, improve soil structure, and have a greater absorption capacity for cations than colloidal clay so that it can increase the value of Cation Exchange Capacity (Cayci et al., 2017).

The treatment without chicken manure gave the lowest height at all ages of observation compared to chicken manure doses of 5 tons.ha^{-1} and 10 tons.ha^{-1}. Cayci et al. (2017) and Rayne & Aula (2020) state that chicken manure can improve the soil's physical, chemical, and biological properties to become more friable. Chicken manure can contribute nutrients that are capable of sufficient plant height growth. This is because nitrogen is an essential nutrient needed in vegetative growth. Nitrogen is used for the formation of chlorophyll. The more chlorophyll that is formed, the resulting photosynthate increases, so the growth and development process increases (Li et al., 2018).

Nitrogen-fixing microbes, namely Azotobacter sp, and phosphate-dissolving microbes, namely Pseudomonas sp, are present in biochar. Moreover, according to Minuț et al. (2022), Azotobacter and Pseudomonas can increase plant growth and yield by adding free nitrogen from the air and dissolving soil phosphate to make it available to plants. In addition, it can also produce growth-stimulating hormones such as IAA (Indole-3-acetic acid), cytokinins, gibberellins, and auxins, which play a role in increasing plant growth and yield.

The treatment without biochar application gave the lowest height at all ages of observation compared to the doses of 7.5 kg.ha^{-1} and 15 kg.ha^{-1} biochar. According to (Liu et al., 2021), applying biochar to agricultural land can increase the soil's ability to store water and nutrients and create a suitable habitat for symbiotic microorganisms. Moreover, Aller et al. (2017) stated that the effectiveness of biochar in improving soil quality is highly dependent on the chemical and physical properties determined by the type of raw material for biochar, where at the beginning of growth, biochar has not been able to provide nutrient availability because it takes time to meet the availability of these nutrients.

Fageria & Oliveira (2014) state that the high availability of N nutrients in chicken manure is a constituent of many compounds, such as amino acids needed for the growth of plant vegetative parts such as stems, leaves, and shoots in plants. Moreover, Kumari (2017) revealed that the provision of nitrogen to plants will encourage the growth of photosynthetic organs, namely leaves. Plants that are adequately supplied with nitrogen will form broader leaves with higher chlorophyll so that plants can produce sufficient amounts of carbohydrates to support vegetative growth.

The function of manure, in general, is to improve the physical, chemical, and biological properties of the soil. The role of organic matter in the physical properties of the soil is to make the soil crumbly structure, good soil aeration where soil aeration is related to water, CO2 gas influences root development, and the life of soil microorganisms (Tale & Ingole, 2015). Hou et al. (2019) stated that leaves function as plants' main organ of photosynthesis. The function of manure, in general, is to improve the physical, chemical, and biological properties of the soil.

Pangestuti et al. (2023) state that the number of shallot tillers varies depending on the variety, usually ranging from 2 – 5 tiller bulbs. The number of tillers of shallot plants is related to the number of leaves; the optimum number of leaves allows light distribution as the formation of photosynthesis between leaves is more even, which will then be deposited on the stems and roots, which affects the number of tillers. High photosynthetic results will provide good plant growth results. Ammar et al. (2018) state that the number of tillers in each clump supports the number of bulbs produced by each plant clump, thus affecting the number or weight of bulbs produced.

Some microorganisms in biochar are nitrogen-solubilizing bacteria, such as Azosprililum and Azotobacter, and phosphate-solubilizing bacteria, Pseudomonas and Bacillus. Okon et al. (2015) state that Azosprillum affects plant growth through mechanisms such as N2 fixation, can produce the hormones auxin, cytokinins, and gibberellins, and increases nutrient absorption and dissolves P elements. Biochar can increase P availability due to its capacity to adsorb phosphate. The extent of the biochar effect on P availability in soil depends on the biochar properties and the pyrolysis conditions (Zhang et al., 2016).

The dosage of chicken manure and biochar was significantly different at each treatment level at all ages of observation on the parameter of the number of tillers of the clump. Srivastava et al. (2014) state that if the availability of nutrients is sufficient, then it will give good growth results; conversely, if the availability of nutrients is lacking, it will affect growth results that are not optimal. For organic fertilizers, such as poultry manure, it has been reported that they improve soil physical, chemical, and biological properties, including bulk density (De Sousa et al., 2021).

Li et al. (2020) state that organic fertilizers play a role in changing soil structure and the availability of nutrients that can support plant growth. Soil with a crumb structure will support plant growth so that when the application of the most manure shows good vegetative growth and plant yields. Aller et al. (2017) state that biochar in improving soil quality is highly dependent on chemical and physical properties, which are determined by the type of Biochar raw material, where at the beginning of growth, biochar has not been able to provide nutrient availability because it takes a long time to meet the availability of these nutrients. At sufficient doses of chicken manure and biochar, the soil's physical, chemical, and biological properties will be better, giving advantages to the physical properties of the soil and increasing structuring. Increased structuring will cause plant roots to develop properly because it creates a crumbly and loose soil atmosphere. This will increase plant productivity. Soil conditioners, such as biochar, are increasingly used to improve tropical soil's important chemical and physical attributes (Agegnehu et al., 2017).

Manure can improve the soil's physical, chemical, and biological properties so nutrients can be adequately absorbed (El-Sheikha, 2016). Organic matter is one of the keys to controlling the ideal soil's physical, chemical, and biological properties to support plant growth and sustainability (Winarso, 2020). Moreover, Salamandane et al. (2022), chicken manure in the dose of 2.65 $kg.m^{-2}$ application represents a sustainable alternative to synthetic fertilizers, mainly in the current challenging situation of agriculture in the context of climate change.

Onion plants, in general, will grow well in soil with a high organic matter content. Low organic matter content is the main obstacle in shallot production. Therefore, organic fertilizer is needed to achieve high shallot production because organic fertilizer can loosen the pores of the soil so that the onion bulbs formed at the base of the roots will grow well. Applying biochar and manure affects shallot production, especially the number of leaves and fresh bulb weight. Utilization of biochar is one of the main parts of biochar agricultural waste management because it can increase soil fertility and shallot production (Pakpahan,2020).

Nkebiwe et al. (2016) state that if the nutrients are in sufficient condition, photosynthesis will run smoothly, so more carbohydrates will be produced and stored as food reserves, increasing the plant's wet weight. Giving manure can improve plant growth by increasing the levels of humus and nutrients in the soil. Biochar treatment with a dose of 15 kg/ha gave a better effect and significantly differed from the treatment with a dose of 0 kg/ha and 7.5 kg/ha. Tale & Ingole (2015) state that by increasing the accumulation of nutrients on the colloidal surface of organic matter, plants will also get more nutrients, which can be used to produce bulbs as an accumulation of photosynthate.

Chen et al. (2021) stated that plants need sufficient and balanced nutrients. The plant's fresh weight will decrease if nutrients are given in excessive or low doses. Lack or excess of nutrients given to plants results in photosynthesis not running effectively, and the photosynthate produced is reduced, causing the amount of photosynthate translocated to bulbs to decrease. The availability of nutrients in the soil in a balanced manner allows plant growth and production to occur correctly.

Azmi et al. (2016) stated that seed bulb size affects the number of bulbs per plant. The provision of biochar with high nitrogen content can accelerate the growth and development of plant organs so that the number of leaves and leaf area increases more quickly (Tandi et al., 2015). In addition, nitrogen contained in bio-agent soil amendments is essential as a protein builder. In contrast, phosphorus and calcium play a role in stimulating the division of meristem tissue root growth and leaf development.

Applying chicken manure and biochar into the soil gave a positive response. Organic matter acts as a source of energy and food for soil microorganisms. The effect is to increase the activity of microorganisms in providing plant nutrients. So, organic matter is added to the soil and is a source of energy and nutrients for microorganisms. Organic fertilizer alone is unlikely to increase crop productivity and product quality (Ayilara et al., 2020).

The application of chicken manure on Allium cepa significantly improved yield, bulb weight, bulb height, number of shoot tips, and number of dried leaves compared to the control. The highest yields (46.31 $tons.ha^{-1}$) were obtained in the parcels where the chicken manure was applied at a rate of 60 $tons.ha^{-1}$ (Yoldas et al., 2019).

According to Turmuktini et al. (2020), the biochar used in the experiment contains compost (40%), Biochar (20%), Dolomite (20%), humic acid (5%), guano (4%), KCl (3%), additives (5%), biofertilizer (3%), Pseudomonas sp and Bacillus sp. As a phosphate-solubilizing microbe, Pseudomonas can increase soil phosphate availability through the dissolution mechanism by organic acids or the degradation of organic phosphate by phosphatase enzymes. Phosphate is a nutrient that plays a role in photosynthesis and root development. Some phosphate is bound by soil colloids, making it available to plants (Rastija et al., 2014). Like all living organisms, plants need nitrogen (N), an essential component of nucleotides and proteins. N also forms the skeleton of chlorophyll and is one of the significant plant macronutrients. Despite being abundant, most N in the atmosphere is inert N2, which is not directly useable by plants (Moreau et al., 2019).

Nitrogen-fixing microbes found in chicken manure provide NH_3, which is then transformed into NH_4^+ and NO_3^- to be absorbed by plants (Kalay et al., 2016). Phosphate solubilizing microbes in biochar increase soil phosphate availability through the mechanism of dissolution by organic acids or degradation of organic phosphate by secreted phosphatases. Phosphates play an essential role in photosynthesis and root development. Soil colloids bind most phosphate forms, so they are unavailable to plants (Rastija et al., 2014). Organic and inorganic phosphate are found in the soil, both of which are essential sources for plants. Chicken manure contains specific elements such as macronutrients and micronutrients in higher amounts than other organic fertilizers. The application of rice husk biochar reduced CO2 fluxes and appeared to improve shallot production, though not as high as the application of chicken manure, which was up to 10 tons.ha^{-1} (Kusuma et al., 2021).

CONCLUSION

There was no interaction between the treatment of chicken manure and biochar on plant height, number of leaves, number of tillers, number of tubers, the weight of tubers, and tubers per plot. The independent effect of giving 10 tons.ha^{-1} of chicken manure and applying 15 kg.ha^{-1} of bio-agent soil conditioner had a better effect on plant height, number of leaves, number of tillers, number of tubers, weight of tubers per plant, and weight of tubers per plot.

ACKNOWLEDGMENTS

We want to give appreciation to the dean of the Faculty of Agriculture and the rector of Universitas Bale Bandung, who have facilitated research and seminars.

REFERENCES

Agegnehu, G., Srivastava, A. K., & Bird, M. I. (2017). The role of biochar and biochar-compost in improving soil quality and crop performance: A review. *Applied Soil Ecology*, *119*, 156–170. https://doi.org/10.1016/j.apsoil.2017.06.008

Aller, D., Rathke, S., Laird, D., Cruse, R., & Hatfield, J. (2017). Fresh and aged biochars impact plant available water and water use efficiency. *Geoderma*, *307*, 114–121. https://doi.org/10.1016/j.geoderma.2017.08.007

Ammar, M., Kurnianingsih, A., Irmawati, Adhistia, Y., & Yuniar, F. (2018). The Correlation Between Growth Characters and Yield of Shallot (Allium Ascalonicum L.) Due To the Application of Nitrogen, Phosphate and Potassium Fertilizers. *Russian Journal of Agricultural and Socio-Economic Sciences*, *81*(9), 502–509. https://doi.org/10.18551/rjoas.2018-09.62

Ayilara, M., Olanrewaju, O., Babalola, O., & Odeyemi, O. (2020). Waste Management through Composting: Challenges and Potentials. *Sustainability*, *12*(11), 4456. https://doi.org/10.3390/su12114456

Azmi, C., Hidayat, I.M., & Wiguna, G. (2016). Effect of Varieties and Bulb Size on Shallot Productivity. *Journal of Horticulture*, *21*(3), 206–213.

Boldea, M., Sala, F., Rawashdeh, H., & Luchian, D. (2015). Evaluation of agricultural yield in relation to the doses of mineral fertilizers. *Journal of Central European Agriculture*, *16*(2), 149–161. https://doi.org/10.5513/JCEA01/16.2.1603

Cayci, G., Temiz, C., & Sözudogru Ok, S. (2017). The Effects of Fresh and Composted Chicken Manures on Some Soil Characteristics. *Communications in Soil Science and Plant Analysis*, *48*(13), 1528–1538. https://doi.org/10.1080/00103624.2017.1373794

Chen, Y., Hu, S., Guo, Z., Cui, T., Zhang, L., Lu, C., … Jin, Y. (2021). Effect of balanced nutrient fertilizer: A case study in Pinggu District, Beijing, China. *Science of The Total Environment*, *754*, 142069. https://doi.org/10.1016/j.scitotenv.2020.142069

Ding, Y., Liu, Y., Liu, S., Li, Z., Tan, X., Huang, X., … Zheng, B. (2016). Biochar to improve soil fertility. A review. *Agronomy for Sustainable Development*, *36*(2), 36. https://doi.org/10.1007/s13593-016-0372-z

Dyah, P. S., & Putra, A. Y. (2021). Comparison of shallot and tobacco farm income in Selopamioro Village, Imogiri Sub District, Bantul District, Yogyakarta. *E3S Web of*

Conferences, *316*. https://doi.org/10.1051/e3sconf/202131602033

El-Sheikha, A. F. (2016). Mixing Manure with Chemical Fertilizers, Why? and What is After? *Nutrition and Food Technology*, *2*(1). https://doi.org/10.16966/2470-6086.112

Fageria, N. K., & Oliveira, J. P. (2014). Nitrogen, Phosphorus and Potassium Interactions in Upland Rice. *Journal of Plant Nutrition*, *37*(10), 1586–1600. https://doi.org/10.1080/01904167.2014.920362

Hasanah, Y., Mawarni, L., Hanum, H., Irmansyah, T., & Manurung, K. R. (2022). The Role of Cultivation Methods and Lowlands Growing Environment on the Growth of Shallot (Allium ascalonicum L.) Varieties. *IOP Conference Series: Earth and Environmental Science*, *977*(1), 012001. https://doi.org/10.1088/1755-1315/977/1/012001

Hou, W., Tränkner, M., Lu, J., Yan, J., Huang, S., Ren, T., … Li, X. (2019). Interactive effects of nitrogen and potassium on photosynthesis and photosynthetic nitrogen allocation of rice leaves. *BMC Plant Biology*, *19*(1), 302. https://doi.org/10.1186/s12870-019-1894-8

Kalay, A.M., Hindersah, R., Talahaturuson, A., Langoi, A.F. (2016). The Effect of Consortium Biological Fertilizers on the Growth and Yield of Mustard Greens (Brassica juncea L.). *Agroekotek Journal*, *8*(2), 131 – 138.

Kumari, S. (2017). Effects of Nitrogen Levels on Anatomy, Growth, and Chlorophyll Content in Sunflower (Helianthus annuus L.) Leaves. *Journal of Agricultural Science*, *9*(8), 208. https://doi.org/10.5539/jas.v9n8p208

Kusuma, E., Wijaya, W., Maas, A., Utami, S.N.H., Maftuah, E. (2021). Effects of rice husk biochar, and raised bed on CO2 flux and shallot (Allium cepa) production on peatland. *Journal of Soil Science and Agroclimatology*, *18*(2), 159-165

Li, J., Shi, Y., Veeranampalayam-Sivakumar, A.-N., & Schachtman, D. P. (2018). Elucidating Sorghum Biomass, Nitrogen, and Chlorophyll Contents With Spectral and Morphological Traits Derived From Unmanned Aircraft System. *Frontiers in Plant Science*, p. 9. https://doi.org/10.3389/fpls.2018.01406

Li, P., Wu, M., Kang, G., Zhu, B., Li, H., Hu, F., & Jiao, J. (2020). Soil quality response to organic amendments on dryland red soil in subtropical China. *Geoderma*, *373*, 114416. https://doi.org/10.1016/j.geoderma.2020.114416

Liu, X., Wei, Z., Ma, Y., Liu, J., & Liu, F. (2021). Effects of biochar amendment and reduced irrigation on growth, physiology, water-use efficiency and nutrients uptake of tobacco (Nicotiana tabacum L.) on two different soil types. *Science of The Total Environment*, *770*, 144769. https://doi.org/10.1016/j.scitotenv.2020.144769

Minuț, M., Diaconu, M., Roșca, M., Cozma, P., Bulgariu, L., & Gavrilescu, M. (2022). Screening of Azotobacter, Bacillus, and Pseudomonas Species as Plant Growth-Promoting Bacteria. *Processes*, *11*(1), 80. https://doi.org/10.3390/pr11010080

Moreau, D., Richard, D., Bardgett, Finlay, R.D., Jones, D.L., Phillippot, L. (2019). A Plant Perspective on nitrogen cycling in the rhizosphere. https://doi.org/10.1111/1365-2435.13303

Mukai, S. (2018). Historical role of manure application and its influence on soil nutrients and maize productivity in the semi-arid Ethiopian Rift Valley. *Nutrient Cycling in Agroecosystems*, *111*(2–3), 127–139. https://doi.org/10.1007/s10705-018-9913-y

Napitupulu, D., Nurzannah, S. E., & Siagian, D. R. (2021). Sustainable shallot production achievement through analyzing the land suitability and introducing the proper agronomic cultivation practices in samosir regency. *IOP Conference Series: Earth and Environmental Science*, *807*(2), 022073. https://doi.org/10.1088/1755-1315/807/2/022073

Nkebiwe, P. M., Weinmann, M., Bar-Tal, A., & Müller, T. (2016). Fertilizer placement to improve crop nutrient acquisition and yield: A review and meta-analysis. *Field Crops Research*, *196*, 389–401. https://doi.org/10.1016/j.fcr.2016.07.018

Okon, Y., Labandera-Gonzales, C., Lage, M., & Lage, P. (2015). Agronomic Applications of Azospirillum and Other PGPR. In *Biological Nitrogen Fixation* (pp. 925–936). https://doi.org/10.1002/9781119053095.ch90

Pakpahan T., Elizabeth, Hidayatulah, T., Mardiana, E. (2020). Application of

Biochar and Manure on Shallot Cultivation in Inceptisol Soil at Medan Agricultural Development Polytechnic Experimental Garden. *Journal Agrica Agrica Ekstensia*, *14*(1).

Pangestuti, R., Sulistyaningsih, E., Kurniasih, B., Murti, R. H., Harper, S., & Subandiyah, S. (2023). Phenological growth stage of tropical shallot (Allium cepa L. Aggregatum group) planted from seed in lowland area based on the BBCH scale. *Annals of Applied Biology*, *182*(2), 257–266. https://doi.org/10.1111/aab.12799

Prabawati, N. F., Pujawan, I. N., & Widodo, E. (2018). Modeling of shallot supply decisions: the case of Indonesia. *IOP Conference Series: Materials Science and Engineering*, *337*, 012016. https://doi.org/10.1088/1757-899X/337/1/012016

Rastija, D., Zebec, V., & Rastija, M. (2014). Impacts of Liming With Dolomite on Soil Ph and Phosphorus and Potassium Availabilities. *13th Alps-Adria Scientific Workshop*, *63*, 267–270.

Rayne, N., & Aula, L. (2020). Livestock Manure and the Impacts on Soil Health: A Review. *Soil Systems*, *4*(4), 64. https://doi.org/10.3390/soilsystems4040064

Salamandane, A., Belo Afonso, M., Ismael, F., Vintuar, P. (2022). Application of chiken manure and organic compost to Produce onion (Allium cepa L.) and Turnip (Brasicca rapa L.) in greenhouse. *European journal of agriculture and food sciences*, *4*(5), 1-6.

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, T. B., Ali, A., Prasad, M., Yadav, A., Shrivastav, P., Goyal, D., & Dantu, P. K. (2020). Role of organic fertilizers in improving soil fertility. In *Contaminants in Agriculture: Sources, Impacts, and Management* (pp. 61–77). https://doi.org/10.1007/978-3-030-41552-5_3

Smita Tale, K., & Ingole, S. (2015). A Review on Role of Physico-Chemical Properties in Soil Quality. *Chem Sci Rev Lett*, *4*(13), 57–66.

de Sousa Lima JR, De Goes M da, C.C., Hammecker, C, Antonino, A.C.D., De Medeiros, É.V., De Sá Barretto Sampaio, E.V., et al. (2021). Effects of poultry manure and biochar on acrisol soil properties and yield of common bean. A short-term field experiments. *Agriculture*, *11*(4), 1–11. DOI: 10.3390/agriculture1104029

Srivastava, V. K., Singh, J. K., Bohra, J. S., & Singh, S. P. (2014). Effect of fertilizer levels and organic sources of nitrogen on production potential of hybrid rice (Oryza sativa) and soil properties under system of rice intensification. *Indian Journal of Agronomy*, *59*(4), 607–612. https://doi.org/10.5194/egusphere-egu21-8182

Suswadi, Prasetyowati, K., Kartikasari, R. D., & Prasetyo, A. (2021). A feasibility study on cultivating shallots (Allium ascalonicum L) in Selo District, Boyolali Regency, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *824*(1), 012111. https://doi.org/10.1088/1755-1315/824/1/012111

Turmuktini, Mulyana, D., Widodo, R.W., Ria, E.R., Kantikowati, E., Muliani, Y., Karuniawan, A., and Simarmata, T. (2020). Agronomic Characteristics and Nodules from Black Soybean Genotypes Due to Application Compost and Biochar as Sustainable Agriculture. *The Journal of Agricultural Sciences - Sri Lanka*. Pp 222-229

Wan, L., Wang, X., Cong, C., Li, J., Xu, Y., Li, X., … Wang, L. (2020). Effect of inoculating microorganisms in chicken manure composting with maize straw. *Bioresource Technology*, *301*, 122730. https://doi.org/10.1016/j.biortech.2019.122730

Winarso, S. (2005). *Soil Fertility, Basic Health, and Soil Quality*. Gravamedia. Yogyakarta.

Yoldas, F., Cevlan, S., Mordoğan, N.S. (2019). Effect of chicken manure on yield and yield criteria of onion (Allium cepa L.) As second crop. *Applied Ecology and Environmental Research*, *17*(5): 12639-1264

Zhang, H., Chen, C., Gray, E.M., Boyd, S.E., Yang, H., Zhang, D. (2016). Roles of biochar in improving phosphorus availability in soils: a phosphate adsorbent and a source of available phosphorus. *Geoderma*, *276*, 1–6.