International Journal of Engineering, Science and Information Technology
Volume 5 No. 2 (2025) pp. 118-122
ISSN 2775-2674 (online)
Website: http://ijesty.org/index.php/ijesty
DOI: https://doi.org/10.52088/ijesty.v5i2.796
Research Paper, Short Communication, Review, Technical Paper

Formulation of Liquid Compound Fertilizer Enriched with Nutritional Elements for Shallot Plants on Inceptisol Reuleut Soil

Fahira, Halim Akbar, Ismadi, Selvy Handayani, Laila Nazirah, Muliana*

Department of Master of Agroecotechnology, Faculty of Agriculture, UniversitasMalikussaleh, Aceh, Indonesia

**Corresponding author Email: muliana@unimal.ac.id*

The manuscript was received on 18 June 2024, revised on 1 October 2024, and accepted on 2 February 2025, date of publication 2 April 2025

Abstract

Shallots (Allium ascalonicum L.) are one of the leading vegetable commodities in Indonesia that have many benefits, such as a flavouring for cooking spices, raw materials for the food industry, and traditional medicinal ingredients. Inceptisol is a soil with a low content of essential nutrients. However, it can still be pursued with the proper technological handling, one of which is the application of Liquid Compound Fertilizer (PMC). This study aims to determine the effectiveness of the liquid compound fertilizer (PMC) formula applied to Inceptisol soil on the growth and yield of shallot plants. This research was conducted at the Experimental Garden, Faculty of Agriculture, Malikussaleh University, from November to December 2023. This study used a single-factor Complete Randomized Design (RAL) with five replicates. PMC treatment consists of 5 levels, namely (K0) Control, (K1) PMC 25%, (K2) PMC 50%, (K3) PMC 75%, and (K4) PMC 100%. The results showed that applying PMC could increase the growth of shallots in the number of cloves and wet and dry crop weight with a PMC concentration of 50%. And PMC treatment of 75% can increase plant height. PMC treatment is 100% able to increase the number of leaves/plants. The application of PMC can affect the chemical properties of the soil, namely increasing the soil's pH value (H2O) by 0.84%, the soil organic by 1.5%, the total N by 2.73%, and the available P by 5.62%.

Keywords: *Shallot Growth Results, Soil Chemical Properties, Liquid Compound Fertilizer*.

1. Introduction

The shallot plant (Allium ascalonicum L.) is a horticultural crop commodity widely consumed by the community as a mixture of cooking spices [1]. Shallots also contain various substances beneficial to health, including anti-cancer substances and antibiotics that can prevent high blood pressure and cholesterol and maintain human blood sugar thresholds. With many benefits and potential economic value, shallots are now one of Indonesia's staple and essential commodities [2].

Based on data from the Central Statistics Agency (BPS) (2022), the decline in shallot production was only 1.97 million tons, while Indonesia's shallot production reached 2 million tons in 2021. One of the causes of the decrease in shallot productivity in Indonesia is the declining soil fertility level due to unbalanced fertilization applications and low use of organic fertilizers. Fertilization can increase and maintain fertility in the soil so that it can provide nutrients needed by plants to support vegetative and generative growth and production and improve the quality of crops.

Efforts that can be made to increase the soil's fertility value include using dry land that is slightly acidic, namely Inceptisol soil, by formulating fertilizers. Inceptisol is a reasonably large soil and has many obstacles to use as agricultural land; the main obstacle in the management of Incepticol Reuleut soil is that the pH (H2O) is somewhat acidic, organic is classified as low, N-total, and P-available is classified as very low, so it is necessary to make efforts to increase the fertility value of Inceptisol soil [3].

Liquid Compound fertilizer (PMC) is a mixture of organic and inorganic materials that become one formula to meet the nutrient needs of shallot plants. The organic matter in this study consists of several types of liquid waste from palm oil mills (LCPKS), liquid waste from urea fertilizer factories (LCPPU), and liquid waste from tofu factories (LCPT). In addition, urea and phosphoric acid (H3PO4) increase soil nutrients for shallot plants' growth. PMCs in the soil raise pH, C-organic, total N- and P-available; PMCs are also a source of nutrients and can increase growth and cause onion crop yields to rise.

LCPKS is an organic material that contains nutrients needed by plants. This is based on the analysis by Saputra et al. (2021), which showed that LCPKS contained 2.808% N nutrients, 0.165% P nutrients, and K nutrients in the application area of 1.003%. Industrial factories that manufacture urea fertilizer (LCPPU) can produce waste that contains nutrients. The N element contained in urea is an excellent nutrient that plants need. Liquid urea fertilizer is more readily available and does not damage the soil and plants. Meanwhile, in LCPT tofu liquid waste, according to the results of Amalia et al. (2022) research, shows that tofu liquid waste contains N 1.24%, P2O5 5.54%, K2O 1.34%, and C-Organic 5.803%, which are essential nutrients needed by plants.

Based on the description above, using liquid waste materials has great potential to improve soil properties and increase shallot yields because shallot plants require the application of nitrogen (N) and phosphorus (P) fertilizers in a reasonably balanced amount to be able to grow and produce optimally [7].

Efforts to increase nutrients in the soil to increase the growth yield of shallots can be made through organic and inorganic matter. Therefore, this study aims to determine the effectiveness of the liquid compound fertilizer (PMC) formula applied to Inceptisol soil on the growth and yield of shallot plants. It is hoped that PMC can increase the fertility and growth of shallot plants.

2. Research Methods

2.1. Place and Time

Fertilizer formulation research and nutrient analysis were carried out in the Soil Science Laboratory, Faculty of Agriculture, and phosphorus analysis at the Chemical Engineering Laboratory, Malikussaleh University, and shallot planting was carried out in the Experimental Garden, Faculty of Agriculture, Malikussaleh University. The research was carried out in November – December 2023.

2.2. Tools and Materials

The tools needed in the research are in the form of a 2 kg white pot, a hoe, and tools used during the analysis in the laboratory, such as shaking bottles, kjedhal units, spectrophotometers, hyacinth pipettes, burets, boiling flasks, analytical balances, volume pipettes, weighing bottles, pH meters, Arlen Meyers, measuring cups, goblet glasses, measuring flasks, and others. The materials used in this study are skeptical soil, shallot seeds of Bima Brebes variety, liquid waste from palm oil mills (LCPKS), liquid waste from urea fertilizer (LCPPU), liquid waste from tofu factories (LCPT), urea fertilizer, phosphoric acid (H3PO4), KOH, equates, boric acid 4%, NaOH 40%, Conway indicator, buffer solution, diphenylamine indicator, K_{2Cr2O7} 1 N, FeSO4 1N, HCl 0.1 N, boric acid 1%, H2SO4 0.05 N, and Nevada aloy.

2.3. Experimental Design

This study uses a single-factor Complete Random Design (RAL) method with five levels and five repetitions, namely: (K0) Control, (K1) PMC 25%, (K2) PMC 50%, (K3) PMC 75% and (K4) PMC 100%. Data from observing the growth and yield of shallot plants in the field will be processed statistically covariant (ANOVA) using the SAS Portable application. If the results of the data analysis have an actual or very real effect, it is further tested with Duncan's Multiple Range Test (DMRT).

2.4. Implementation of Research

This research was carried out in three stages, namely:

Stage 1 of the Making of Liquid Compound Fertilizer (PMC)

PMC preparation The materials used for PMC formulation consist of three liquid wastes, namely palm oil mill liquid waste (LCPKS), urea mill liquid waste (LCPPU) and tofu factory liquid waste (LCPT), urea fertilizer and 85% phosphoric acid (H3PO4). PMC was carried out by weighing 56.09 g of urea and pipetting 85% phosphoric acid (H3PO4) as much as 22.85 ml. Three wastes are mixed, namely 75 ml of palm oil mill liquid waste (30%), 75 ml of urea factory liquid waste, and 100 ml of tofu factory liquid waste (40%), stirred until dissolved and labelled in a 250 ml measuring flask. Analysis was conducted on PMC, namely pH, C-organic, Nitrogen, and Phosphorus. Then, add the aquadest to the boundary mark. PMC is dissolved, stored in the chamber for 1 week, and ready for use.

Stage 2 Initial and Final Soil Sampling

The soil used for this study is Inceptisol Reuleut soil. Soil sampling uses a hoe at a 0-20 cm depth. The soil is then sifted using a sand sieve; then, the soil is composited. The initial soil sample is then dried and aerated for 10 days, after which the soil is smoothed and sifted with a 2 mm sieve, and 1 kg of soil is taken for the initial analysis parameters. The final soil of the study was carried out at the age of 65 HST. The soil sampling technique was to pull the plants into pots and stir the soil until homogeneous. Soil samples were taken from each pot according to the treatment, as much as 200 g, and put into plastic labelled according to the treatment. Then, the soil is dried and aerated in the laboratory for 10 days; after the soil is dried, the soil is smoothed and sifted with a 2 mm sieve. The Initial and final soil analysis parameters are pH (H2O), C-organic, N-total, and P-available.

Stage 3 Planting shallots

Preparation of Inceptisol soil planting media: the soil is first cleaned of dirt such as grass and plant roots, then dried, aerated for 3 days, then homogenized and sifted with a sand sieve, then the soil is put into a 2 kg pot. Then, the planting medium is watered and incubated for 1 week; after 1 week, the shallots are planted and placed in a plastic house with a planting distance of 15 × 15 cm. The type of shallot cultivation used is the Bima Brebes variety of shallots. The onion bulbs are cut $^1/_3$ of the tip of the onion seedlings, aiming to accelerate the sprout growth process. The application of PMC on shallot plants is diluted first with concentrations of 0%, 25%, 50%, 75% and 100%, respectively. After being diluted, PMC is given at the age of 7 days after planting (HST), and then fertilizer is given at a dose of 50 ml/plant. It is done in the afternoon by watering the soil about 2 cm between the onion bulbs. The maintenance of shallot plants includes watering the plants every day using water. Weed control is achieved by plucking and embedding it into the growing medium. The observed variables were plant height, number of leaves, tillers, and wet and dry crop weights.

3. Results and Discussion

3.1. Initial Soil Test

Table 1. Results of Initial Soil Analysis

It	Soil Properties	Value	Criteria*)
1.	pH (H2O)	6,27	Slightly sour
2.	C-organic (%)	2,55	Keep
3.	N-total (%)	0,33	Keep
4.	P available (ppm)	22,17	Tall

Description: *) Soil Research Institute, 2009

Based on Table 1, Inceptisol at the study site showed a slightly sour pH level of 6.27. H C-organic results and N-total are classified as very moderate criteria. The available P results are classified as high criteria. Soil with these conditions has obstacles to being used as a planting medium for plant cultivation. One effort that can be made to increase the fertility value of the soil is fertilization. Inceptisol soil generally has less fertile soil properties, including a slightly acidic pH, moderate organic C levels, and low N nutrients [8].

3.2. PMC Analysis Results

Table 2. PMC Analysis Results

It	Parameters	Value
1.	pH (H2O)	6,94
2.	Organic Carbon (C) (%)	13,57
3.	Nitrogen (%)	29,80
4.	Phosphorus (%)	9,77

Table 2 is the result of the analysis of the chemical properties of PMC, known as pH, C-organic, Nitrogen, and phosphorus, which has met the quality standards of liquid organic fertilizer and can increase fertility and nutrient supply in Inceptisol soil. Table of quality standards for Minimum Technical Requirements for the Quality of Organic Fertilizers, Biological Fertilizers and Soil Amendments of the Ministry of Agriculture No. 261 of 2019 Liquid Organic Fertilizers.

3.3. Components of Shallot Plant Growth and Yield

3.3.1. Plant Height

The results of the variety analysis showed that the interaction of several concentration treatments had a real effect on the plant height variable starting on the 20th day after planting. The average height of shallot plants aged 10 to 50 HST due to the administration of several concentrations of PMC is presented in Table 3.

Table 3. Effect of PMC Concentration on Average Plant Height (cm)

Treatment	Plant Height (cm)				
	10 HST	20 HST	30 HST	40 HST	50 HST
K0 (0%)	19.14 ab	25,92	32.26 cb	38.94 b	41.76 b
K1 (25%)	18.04 b	23,12	31.19 c	37.58 b	42.16 b
K2 (50%)	20.16 ab	27,28	36.89 ABC	40.96 ab	43.69 b
K3 (75%)	23.98 A	29,02	40,24 A	45.06 A	47,84 A
K4 (100%)	22.08 ab	28,22	38.26 ab	41.02 b	44.91 ab

Remarks: Numbers followed by the same letter in the same column do not differ significantly from the DMRT test at the level of 5%

Table 3 shows that the highest result at 10 HSTs was obtained in the K3 treatment of 23.98 cm, while the lowest was K1 of 18.04 cm. Observation of plant height at the next HST up to 50 HST shows that K3 is better than K0. The height of K3 plants is twice as good as K0.

The observations at the age of 20-50 HST showed that applying PMC with several concentrations had a real effect on plant height and was the best treatment at K3 concentrations compared to K0. The increase in plant height is thought to be closely related to macronutrients, one of which is nitrogen. This is due to the addition of inorganic fertilizers that contain sufficient amounts of macronutrients needed by plants. Good inorganic fertilization for plants is a fertilizer with a combination of three nutrients: Nitrogen, Phosphorus, and Potassium because it is a primary nutrient and is often a limiting factor in plant growth. N and P fertilizers are chemical fertilizers that are quickly available to affect plant height growth immediately.

3.3.2. Number of Leaves

The results of the variety analysis showed that the interaction of several concentration treatments had a real effect on the variable of leaf count starting on the 20th day after planting. The average number of leaves of shallot plants at the age of 10 to 50 HST due to the administration of several concentrations of PMC is presented in Table 4.

Table 4. Effect of PMC Concentration on the Number of Leaves of Shallot Plants (Strands)

Treatment	Number of Leaves (strands)				
	10 HST	20 HST	30 HST	40 HST	50 HST
K0 (0%)	15.80 b	19.80 b	22.20 c	28.20 d	33.60 C
K1 (25%)	18.20 ab	21.80 ab	25.20 BC	32.40 cd	36.40 c
K2 (50%)	20.40 ab	22.40 ab	25.60 BC	35.40 BC	39.80 BC
K3 (75%)	22,20 A	25.60 A	27.80 ab	39.20 ab	43.20 ab
K4 (100%)	23,20 A	26.60 A	30.80 A	41.60 A	46,40 A

Remarks: Numbers followed by the same letter in the same column do not differ significantly from the DMRT test at the level of 5%

Table 4 shows that the highest results in 10 HSTs were obtained in the K4 treatment of 23.20 pieces, while the lowest was K0 of 15.80. Observation of the number of leaves in the next HST up to 50 HST shows that K4 is better than K0. The observation results at the age of 20-50 HST showed that administering PMC with several concentrations had a real effect on the number of leaves and was the best treatment at the concentration of K4 compared to K0. The increase in the number of leaves in shallot plants due to sufficient nutrients allows the optimal photosynthesis process, and the resulting assimilate can be used as food reserves. This is by the statement [9] This condition is because in this treatment, the nutrients needed by plants are suitable, manure added with urea and phosphoric acid can increase the availability of nutrients in the soil such as element N, the availability of element N can increase vegetative growth, significantly the increase in the number of leaves.

3.3.3. Number of Cloves, Weight of Wet and Dry Straws

The results of the variety analysis showed that the interaction of several concentration treatments had a real effect on the weight variables of wet and dry conditions, starting at the age of 50 days after planting. The average weight of damp and dry pruning in onion plants at the age of 50 HST due to the application of several concentrations of PMC is presented in Table 5.

Table 5. Effect of PMC Concentration on Wet and Dry Crop Weight of Shallot Plants

Treatment	Number of Cloves / Plant	Wet Crop/Plant Weight (g)	Dry Crop/Plant Weight (g)
K0 (0%)	5.40 c	21.58 c	16.48 c
K1 (25%)	6.20 bc	24.66 BC	19.34 BC
K2 (50%)	9.20 A	34.70 A	27,43 A
K3 (75%)	8.20 A	28.15 ABC	23.43 ab
K4 (100%)	7.80 ab	29.83 ab	24.98 ab

Remarks: Numbers followed by the same letter in the same column do not differ significantly from the DMRT test at level 5

Table 5 shows that the best treatment for 50% PMC concentration is 9.20 cloves per plant, significantly different from no PMC treatment (D0), which is 5.40 cloves per plant. This is because the nutrient content in PMC plays a vital role in forming the number of cloves, especially the N nutrient.

Table 5 of the study's results on the observation of 50 HST, the best wet shallot weight was found in PMC treatment with a concentration of 50% (K2) of 34.70 g compared to no PMC treatment (K0) of 21.58 g. The increase in the weight of wet pruning in the D2 treatment was 13.12% compared to K0. This is because PMC mixtures can increase organic matter in the soil and provide nutrients that shallot plants need. This is based on the results of the study [10]. Applying tofu liquid waste treatment to the fresh weight of tubers per hectare with a treatment of 45% yielded the highest fresh weight of tubers per hectare.

Based on Table 15, the results of the study on the observation of 50 HST, the best dry shallot weight was found in PMC treatment with a concentration of 50% (K2) of 27.43 g compared to no PMC treatment (K0) of 16.48 g. The increase in dry pruning weight in K2 treatment was 10.98% compared to K0. This is because PMC administration achieves optimal doses, so it tends to meet the nutrient needs of shallot plants compared to other treatments. The application of liquid fertilizer with a concentration of 50% and N and P fertilizers according to the recommended dosage is sufficient to meet the needs of absorbed nutrients so that it can maintain the dry weight of onion bulbs. This is by research [11]. Plant growth is characterized by an increase in the dry weight of the plant; an increase will follow the optimal availability of nutrients for the plant in photosynthesis activity that produces more assimilates, which will support the dry weight of the plant.

3.4. Chemical Properties of Inceptisol Soil

Table 6. Chemical Properties of Soil After Research Due to PMC Application

Treatment	pH (H20)	Criteria*)	C-organic (%)	Criteria *)	N-total (%)	Criteria *)	P-available (ppm)	Criteria *)
K0 (0%)	6,30	Slightly Sour	2,36	Keep	0.33	Keep	21,99	Very high
K1 (25%)	6,50	Slightly Sour	3,16	Tall	1.08	Very high	25,37	Very high
K2 (50%)	6,83	Neutral	3,45	Tall	1.67	Very high	26,02	Very high

K3 (75%)	7,14	Neutral	3,65	Tall	3.06	Very high	27,38	Very high
K4 (100%)	6,72	Neutral	3,86	Tall	2.66	Very high	27,61	Very high

Description: *) Soil Research Institute, 2009

The results of soil analysis after the study of Table 6 showed an increase in soil pH, which, in the initial treatment, K0 and K2 obtained a rather sour pH. The soil's pH increases due to PMC being applied to it. PMCs can affect pH values because residues from PMC content can still increase soil pH. An increase in pH can increase the retention of base cations with an increase in negative charge on the colloid surface through dissociation (H+) of the hydroxyl group.

The C-organic content in the soil has increased significantly compared to the soil conditions at the beginning of the study. The increase in C-organic value is because the organic matter contained in PMC content has been composed to be available in the soil. PMC contains organic C-nutrients, which are essential nutrients plants need. The content of PMC is a composition of organic matter in the form of proteins, carbohydrates, and fats. All of this organic matter can affect the concentration of C-organic in the soil [6].

After the study, the nutrient content of soil N generally increased in all treatments. However, the total N-content of soil was reduced in the K4 treatment with a concentration of 100%. This can be because N nutrients are easily lost from the soil due to nutrient leaching, evaporation, and plant absorption. This is in line with the results of the research. According to Nurmegawati et al. (2007), some of N is transported by harvest, some return as plant residues, disappear into the atmosphere, and return lost through leaching. In addition, this result can also be caused by the acidic soil conditions in the research land.

In soil, P nutrients are generally increased in all treatments. The increase in P-availability of soil and the elongation of plant roots makes the diffusion contact between plant roots and P in the soil more significant so that plants can absorb more P. This is the opinion of Siregar et al. (2023); namely, the amount of P absorption of plants depends on the availability of P element in soil solutions and plant roots.

From the results of the final soil analysis of the experiment, it can be stated that applying PMC fertilizer with a dose of 50 ml can maintain the yield of shallots and soil fertility of Inceptisol Reuleut.

4. Conclusion

Administration of PMC with a dose of 50 ml and a concentration of 50% tended to show better growth and production in shallot plants. The results showed that applying PMC affected soil chemistry, increasing the soil's pH value (H2O) by 0.84%, C-organic soil by 1.5%, N-total by 2.73%, and P-available by 5.62%. The response of shallot plants to the application of several concentrations of PMC significantly affected the parameters of plant height, number of leaves, number of tillers, and wet and dry brow weight.

References

[1] P. Dan, H. Tanaman, And B. Merah, “Pengaruh Konsentrasi Larutan Hara Ab Mix Dan Poc Terhadap Pertumbuhan Dan Hasil Tanaman Bawang Merah (Allium Cepa Var. Ascalonicum) Yang Ditanam Dengan Sistem Wick,” Vol. 3, No. 2, Pp. 26–36, 2022.

[2] A. S. Nuraini, P. Utama, And A. H. Sodiq, “Efek Pemberian Kompos Dan Biochar Terhadap Pertumbuhan Bawang Merah (Allium Ascalonicum L.) True Shallot Seed Pada Typic Hapludults," *Soilrens*, Vol. 20, No. 2, P. 61, 2023, Doi: 10.24198/Soilrens.V20i2.45265.

[3] A. P. Tarigan, Supriadi, And A. Lubis, “Perubahan Beberapa Sifat Kimia Tanah Inceptisol Dan Pertumbuhan Tanaman Jagung (Zea Mays L.) Akibat Pemberian Kompos Kulit Durian Dan Pupuk Sp-36,” *J. Pertan. Trop.*, Vol. 5, No. 3, Pp. 309–317, 2018.

[4] F. Saputra, G. Tampubolon, And I. A. Mahbub, “Pengaruh Aplikasi Limbah Cair Pabrik Kelapa Sawit Terhadap Serapan Hara N,” *J. Agroecotenia*, Vol. 4, No. 2, Pp. 60–65, 2021.

[5] K. S. Dadap And P. S. Utara, “Respon Pertumbuhan Dan Produksi Tanaman Bayam Merah (Amaranthus Gangeticus) Terhadap Pemberian Limbah Cair Pabrik Kelapa Sawit Dan Pupuk Urea,” Vol. 12, No. 3, Pp. 1–10, 2016.

[6] R. N. Amalia *Et Al.*, “Potensi Limbah Cair Tahu Sebagai Pupuk Organik Cair Di Rt. 31 Kelurahan Lempake Kota Samarinda,” *Abdiku J. Pengabdi. Easy. Univ. Mulawarman*, Vol. 1, No. 1, Pp. 36–41, 2022, Doi: 10.32522/Abdiku.V1i1.38.

[7] I. Noor *Et Al.*, “Pengembangan Formula Dan Pembuatan *Controlled Release Fertilizer* (Crf) Untuk Bawang Merah,” *Vegetalika*, Vol. 11, No. 3, P. 196, 2022, Doi: 10.22146/Veg.65667.

[8] A. Yuniarti, E. Solihin, And A. T. Arief Putri, “Aplikasi Pupuk Organik Dan N, P, K Terhadap Ph Tanah, P-Tersedia, Serapan P, Dan Hasil Padi Hitam (Oryza Sativa L.) Pada Inceptisol,” *Kultivasi*, Vol. 19, No. 1, P. 1040, 2020, Doi: 10.24198/Kultivasi.V19i1.24563.

[9] Supriadi, H. Yetti, And S. Yoseva, “Pengaruh Pemberian Pupuk Kandang Dan N, P Dan K Terhadap Pertumbuhan Dan Produksi Tanaman Bawang Merah (*Allium Ascalonicum* L.),” *Jom Faperta*, Vol. 4, No. 1, Pp. 1–12, 2017.

[10] M. Sinaga, “Pengaruh Limbah Cair Tahu Terhadap Pertumbuhan Dan Hasil Tanaman Mentimun (Cucumis Sativus L.),” *Piper*, Vol. 14, No. 26, Pp. 46–54, 2018, Doi: 10.51826/Piper.V14i26.125.

[11] Y. Yusmalinda, “Dengan Pemberian Beberapa Dosis Kompos Tandan Kosong Kelapa Sawit (Tkks) Responses Of Onion (Allium Ascalonicum L .) Toward Four Doses Of Empty Palm Bunches Compost (Epb)," *Jom Faperta*, Vol. 4, No. 1, Pp. 1–10, 2017.

[12] Ermadani And A. Muzuar, “Pengaruh Aplikasi Limbah Cair Pabrik Kelapa Sawit Terhadap Hasil Kedelai Dan Perubahan Sifat Kimia Tanah Ultisol,” *J. Agron. Indones.*, Vol. 39, No. 3, Pp. 160–167, 2011.