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The Application of Organic Liquid Fertilizer C.glomerata and NPK Phonska to Enhance Agronomic Efficiency in Maize Cultivation on Alluvial Soil

ABSTRACT

The objective of this research was to determine the role of Organic Liquid Fertilizer C.glomerata (OLFC) in increasing the efficiency of NPK Ponska fertilizer, influencing soil chemical reactions, and enhancing the growth and yield of maize on alluvial soils. The materials included hybrid maize of the Pioneer 32, OLFC, and NPK Phonska (15-15-15). The experiment was arranged in a Completely Randomized Design (CRD) in factorial. The OLFC was applied at (0 ml L-1, 5 ml L-1, and 10 ml L-1), and NPK Phonska fertilizer at (0,150, and 300 kg ha-1, in three 3 replications. Data obtained were statistically analyzed with Analysis of Variance (ANOVA) at 5%. Level of significance and mean separation using the Least Significant Difference (LSD) at 5% probability. Observations included soil chemical properties, and Agronomic factors such as crop height, net assimilation rate, relative growth rate, weight of 100 seeds, yield, and Agronomic Efficiency (AE). The highest maize yield recorded was 4.83 tonnes each hectare, achieved through the application of 150 NPK Phonska kg each hectare, supported by a fertilization efficiency of 11.28%. Providing 5 ml each liter of OLFC every 2 weeks to maize plants resulted in the highest AE, reaching 21.81%.

Keywords: OLFC, NPK ponska fertilizer, maize growth, soil chemical reactions, agronomic efficiency

1. INTRODUCTION

Maize is a primary food commodity in Indonesia, second only to rice, and is cultivated extensively in the country. Despite significant production, Indonesia imported almost 1.5 million tons of maize in 2023 [1]. The demand for grain maize is particularly high due to its extensive use in the animal feed industry. Employing appropriate maize cultivation techniques is crucial to enhance yield productivity and quality, consequently reducing the dependence on maize imports. Intensive maize cultivation is vital in Indonesia to meet the growing demand for this staple crop. One challenge faced in Indonesia is that the land designated for maize cultivation is often classified as marginal [2, 3]. Additionally, the generally low soil acidity (pH) negatively impacts maize yields. The substantial reliance on inorganic fertilizers poses a challenge for farmers, as increasing fertilizer prices make their application less feasible, potentially leading to decreased maize yields [4]. Fertilization is crucial in maize cultivation, and inorganic fertilizers can be expensive. Therefore, it is important to provide alternative fertilizers to reduce dependence on inorganic fertilizers. Fertilizers play a critical role in enhancing soil productivity, and there are two main types used: organic and inorganic. While inorganic fertilizers can quickly boost soil productivity, they may have adverse effects on soil quality over time. Notably, the government-subsidized Ponska NPK Fertilizer (15-15-15), with its low nutrient content, is widely used in food crop cultivation [5]. However, its effectiveness often requires supplementation with other nutrient sources to meet the comprehensive nutritional needs of plants.

According to [6], utilizing marginal dry land for crop cultivation can lead to complex nutrient deficiency stress affecting the growth of maize plants. Many of these lands suffer from deficiencies in essential macro-nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), while simultaneously experiencing an increase in toxic elements like aluminum (Al), and iron (Fe). While high-dose chemical fertilization is an option to address these issues, it comes with limitations, particularly in terms of cost, especially when applied to large areas. This poses a challenge for many Indonesian farmers with limited working capital. According to [7] it becomes crucial to explore cost-effective and environmentally safe fertilizer alternatives such as liquid organic fertilizers.

The application of *Chromolaena odorata* liquid organic fertilizer has been proven successful and can increase rice yields by up to 25% [8, 9], melon [9], and soybeans [10]. Various types and engineering technologies for the production of liquid organic fertilizers are expected to be innovations in increasing the effectiveness of liquid fertilizers to efficiently use inorganic fertilizers. Various types of organic matter, such as Cladophora glomerata (C.glomerata) which is a macroscopic blue-green algae with more than 183 species, often found in drainage canals or rivers can be used as raw material for making liquid organic fertilizer. These algae can live in freshwater or salt water, which has a low nutrient content, so it is more effective in procuring C.glomerata algae [11]. This algae will bloom when the nutrient content of lake or river water increases due to the excessive application of fertilizers on agricultural land. In shallow lakes or ponds. C.glomerata can breed up to 4 kg m-2 wet weight [12]. Maximum production occurs of C.glomerata in summer and results from 2 short periods of intensive vegetative growth (June and September) where nutrients are sufficiently available from tributaries [13]. Patterns of photosynthesis were studied in July and April for C.glomerata (L.) Kütz populations from open and on shaded sites, revealing a higher capacity for heat energy dissipation and increased total amount of xanthophyll cycling pigments (21%) in samples from the open.

C.glomerata algae exhibit a diverse range of macro and trace nutrients along with amino acids. The macronutrient content in C.glomerata algae includes approximately 1.46-4.15 ppm of nitrogen (N), 0.16-0.49 ppm of phosphorus (P), 3.2-6 ppm of potassium (K), 26.16-27.16 ppm of calcium (Ca), and 0.26-0.42 ppm of magnesium (Mg). Additionally, trace elements such as zinc (Zn), copper (Cu), chromium (Cr), nickel (Ni), and lead (Pb) are also present. The algae contain 16 types of amino acids, with glutamic acid, aspartic acid, and leucine being the most abundant. The biomass typically consists of amino acids ranging from 16.35 g kg^{-1} to 37.63 g kg^{-1} dry matter [14]. [15] reported the nutritional content of C.glomerata, which includes protein (14.26%), carbohydrates (64.52%), lipids (0.55%), and ash (20.73%). The algae also contain total chlorophyll (9.06 ±0.07 µg mL-1) and total carotene (756.4 ±0.05 µg mL-1). The high protein content can contribute nitrogen as a nutrient for plant growth [16]. Biomass from Cladophora can be successfully utilized as a raw material for producing value-added products. Cladophora spp. exhibit potential applications across various fields, including human and animal health, agriculture (such as organic fertilizers, plant growth biostimulants, and feed additives), environmental protection (acting as bioindicators of pollution/contamination and absorbing pollutants from wastewater), renewable energy sources (e.g., biogas and bioethanol), and high-tech composite materials [12]. While C.glomerata has been utilized in various applications such as animal feed and the production of cosmetic and pharmaceutical products, there is limited information on its use in the creation of liquid organic fertilizer [17].

The decomposition process of amino acids during the production of liquid fertilizer can release nitrogen (N) elements, contributing to the N nutrient content beneficial for plant growth. Therefore, understanding the impact of applying liquid organic fertilizer from OLFC on the growth and yield of maize in alluvial soils becomes essential. The objective of this research was to determine the role of OLFC in increasing the efficiency of NPK Ponska fertilizer, influencing soil chemical reactions, and enhancing the growth and yield of maize on alluvial soils.

2. METHODS

The experiment was carried out on alluvial soil in Anduriang Village, Kuranji District, Padang City. The materials used in the study were Pioneer 32 organic hybrid maize, OLFC, and NPK Phonska (15-15-15). The experimental design included two main factors: 1) the first factor involved the application of OLFC with three levels; 0, 5, and 10 ml L^{-1}; 2) the second factor was the dosage of Phonska NPK Fertilizer (15:15:15), comprising three levels; 0, 150, and 300 kg ha^{-1}. The experiment was arranged in a CRD in factorial. The OLFC was applied at three rates: 0 ml L^{-1}; 5 ml L^{-1} and 10 ml L^{-1}; NPK Phonska Fertilizer; at 0, 150, and 300 kg ha^{-1}, in 3 replications.

Data obtained were analyzed statistically with ANOVA at 5% level of significance, and mean separation using the LSD at 5% probability. For the preparation of OLFC, the procedure involved combining 15 liters of rainwater with 1 kg of Chladophora glomerata algae, 1 young coconut water, 100 g of $Ca(OH)_2$, 100 g of NaCl, 100 g of monosodium glutamate (MSG), 100 g of onion, and 100 g of honey. All the ingredients were finely chopped to a length of 2 mm. In a bucket, young coconut water, Mono Sodium Glutamate, whiting, and honey were placed and left to ferment for 1 week. Subsequently, 15 liters of water were added, and the mixture was dried for 1 week until it changed color to golden yellow. This prepared OLFC was then applied to the experimental maize plots.

Experimental plots were created with dimensions of 300 cm x 200 cm, using a spacing of 50 cm x 25 cm, employing a 2:1 legowo pattern, and maintaining a 50 cm distance between plots. The maize seeds were treated with 5 g kg-1 of Ridhomil 50 EC fungicide to prevent downy mildew. The OLFC was applied 14 Days After Planting (DAP) and continued every 2 weeks until the primordial phase of the plants appeared. The application of OLFC was then discontinued. The NPK Phonska was applied at 7 DAP by arranging them in rows between plants and buried into the soil. Observation parameters included soil chemical properties such as pH, and agronomic properties of plants, comprising plant height, Net Assimilation Rate (NAR), plant Relative Growth Rate (RGR), Leaf Area Index (LAI), weight of 100 seeds, maize yield each hectare. AE was determined by calculating AE using the formula 1 [14] below.

$$AE = \frac{(\text{Plant production with fertilizer} - \text{Plant production without fertilizer})}{\text{Amount of fertilizer given}} \times 100\%$$

The Soil pH, plant height, and LAI were set at 45 DAP. Soil sampling for pH determination was conducted in each experimental plot at 0-15 cm, focusing on the rhizosphere area. Determination of Net Assimilation Rate (NAR) and plant RGR was performed by destroying the plants twice at 30 DAP and 45 DAP. The weight of 100 seeds and the harvest of maize cobs each hectare is determined at 120 DAP. The soil chemical analysis involved the determination of N-total, P-total, and K-total in both the soil and OLFC. N-total Determination: Kjeldahl method, procedure: Used 5 ml of concentrated H_2SO_4 and 1 g of $CuSO_4$ catalyst. P-total and K-total Determination: UV-Vis spectrophotometer method. Procedure: Used 5 ml of concentrated HNO_3 and 5 ml of concentrated H_2SO_4 for the determination of P. A buffer solution with pH 7 was used to determine K. pH Determination: pH electrode, procedure: Used a soil-to-water ratio of 1:2.5 for both soil and liquid fertilizer samples. Soil samples were taken to determine pH at a depth of 0-15 cm around the root rhizosphere randomly in each experimental plot. These analyses provide essential information about the nutrient content and acidity of the soil as well as the liquid organic fertilizer. The Kjeldahl method is commonly used for nitrogen determination, while UV-Vis spectrophotometry is a reliable method for phosphorus and potassium determination. N-total Determination: Kjeldahl method, procedure: Used 5 ml of concentrated H_2SO_4 and 1 g of $CuSO_4$ catalyst. The pH determination is crucial as it indicates the acidity or alkalinity of the soil and fertilizer, which can influence nutrient availability to plants. The specified procedures and methods ensure accurate measurements of these parameters. Soil chemical analysis, including soil pH, was conducted before the experiment, with an additional soil pH determination performed at 45 DAP.

3. RESULTS AND DISCUSSIONS

3.1 The soil chemical analysis and OLFC

The results of the initial soil chemical analysis and OLFC are presented in Table 1. Where the key findings are as follows: 1) Soil Chemical Reaction (pH): Slightly acidic; 2) Nitrogen (N) Content: Moderate; 3) Phosphorus (P) Content: Very high; 4) Carbon-Organic Content: Very low; 5) Potassium (K) Content: Low; and 6) The soil's slightly acidic pH, coupled with moderate nitrogen levels and very high phosphorus content, suggests conditions that may impact the growth of maize plants throughout their vegetative and generative phases. The low organic carbon content and low potassium levels can also influence plant development.

Table 1. Results of initial soil chemical analysis and OLFC

Substance	pH	Total N (%)	P	K	Organic-C (%)
Soil	6.18^{sa*}	0.326^{m*}	36.62 ppm^{vh}	18.59 $me/100g^{l}$	1.026^{l}
Algae *C.Glomerata*	-	2.30%	0,20%	2.60%	13,12
OLFC	6.2^{sa}	0.720%	0,342 (%)	0.692%	Not measurement

$*^{m}$=moderate; ^{vh}=very high; ^{l}=low; ^{a}=acid; ^{sa}=slightly acid; Criteria for determining soil chemical analysis based on (Agus, 2023).

The historical land use for lowland rice cultivation and the associated intensive fertilization practices have left a significant impact on the soil's nutrient composition, particularly the high phosphorus content. This information is crucial for understanding the current state of the soil and its potential implications for maize growth. The high phosphorus levels, while beneficial in some respects, may also pose challenges, as excessive nutrient concentrations can lead to imbalances and affect overall plant health. Further analysis and monitoring will be essential to assess how maize plants respond to these soil conditions, especially considering their nutrient requirements at various growth stages. The initial soil characteristics serve as a baseline for ongoing research and management decisions. By closely monitoring the maize growth and adjusting fertilization practices accordingly, it will be possible to optimize conditions for higher productivity and better overall crop health.

3.2 Plant height of Maize

The application of OLFC, accompanied by the use of Phonska compound NPK fertilizer (15-15-15), showed a highly significant interaction with the height of maize at 45 DAP (see Fig.1 and Table 2). Providing OLFC alone did not increase plant height if Phonska's artificial fertilizer was not applied. With the administration of 150 kg ha^{-1} Phonska, increasing the OLFC dose led to an increase in maize plant height, reaching 122. However, this was not the case when increasing the dose of Phonska further.

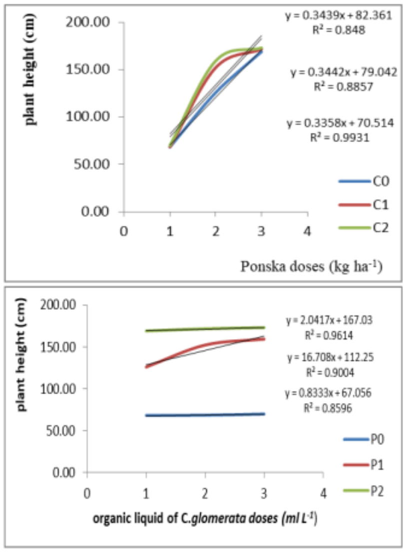

Figure 1. Plant height affected by Phonska and OLFC at 45 DAP

Table 2. Effect of OLFC application and Phonska compound fertilizer on maize height at 45 DAP

NPK (kg ha^{-1})	OLFC (ml L^{-1})		
	0	**5**	**10**
		------ cm------	
0	68.08 Ac	68.33 Ac	69.75 Ac
150	125.75 Bb	152.08 Ab	159.17 Ab
300	168.83 Aa	171.58 Aa	172.92 Aa
CC (%)	6.23%		
LSD.05	13.74		

Numbers followed by the same uppercase letters in the same rows and lowercase letters in the same columns are not considered statistically significant according to the LSD at a 5% level.

3.3 The NAR and RGR of Maize Plants

The results of the statistical analysis revealed an interaction between the application of Phonska's NPK and OLFC on the NAR and RGR, as shown in Fig 2 and Table 3. The highest NAR was observed when applying 0 kg ha-1 of NPK Phonska along with 10 ml L^{-1} of OLFC, resulting in 1.439 mg cm^2 each day. This implies that the photosynthate production was higher in the treatment without inorganic fertilizers. The highest RGR of maize plants occurred in the treatment with 0 kg ha-1 of NPK Phonska combined with 10 ml L^{-1} of OLFC, reaching 48.2 mg day^{-1}. As the OLFC dose increased, there was a corresponding decrease in the RGR of maize, mirroring the pattern seen with a dose of 150 kg ha^{-1} of NPK Phonska. In the case of the administration of 300 kg ha-1 of NPK Phonska, an increase in the OLFC dose led to a linear increase in RGR. The optimal application of NPK Phonska fertilizer in this treatment was found to be 300 kg ha^{-1}. These plants exhibited a positive response to OLFC, as an increase in OLFC doses correlated with an increase in the RGR of maize. In the administration of 300 kg ha^{-1} of Phonska NPK, the linear graphical representation suggests the potential for further increasing the OLFC dose to enhance the RGR.

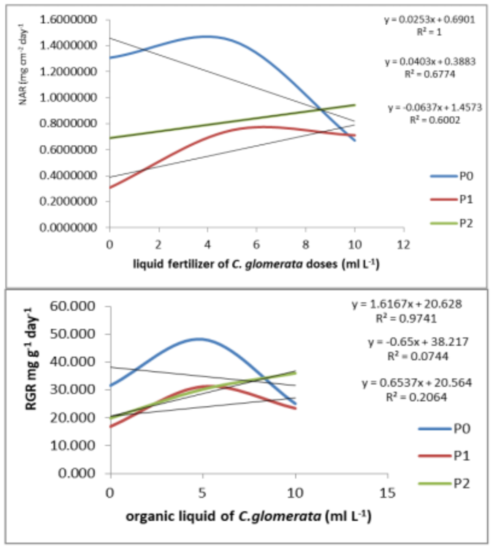

Figure 2. NAR (1) and RGR (2) of maize plants affected by Phonska and OLFC

Table 3. The NAR and RGR of Maize from 30 DAP to 45 DAP

NPK (kg ha^{-1})	NAR mg cm^{-2}day^{-1}			RGR mg g^{-1} hari^{-1}		
	OLFC (ml L^{-1})			OLFC (ml L^{-1})		
	0	5	10	0	5	10
0	1.307 Aa	1.[illegible]9 Aa	0.671 Bb	31.600 Ba	48.200 Aa	25.100 Bb
150	0.308 Bb	0.750 Ab	0.711 Ab	16.863 Bb	31.233 Ab	23.400 ABb
300	0.690 Bb	0.8167 ABb	0.943 Aa	19.867 Bb	30.233 ABb	36.033 Aa
CC (%)		18,52			19.96	
LSD 0.05		0.000270			0.00999	

Numbers followed by the same uppercase letters in the same rows and lowercase letters in the same columns are not considered statistically significant according to the LSD at a 5% level.

3.4 The Soil pH, LAI, and 100 seeds weight of Maize

The soil pH range at 45 DAP ranges from 5.71 to 6.01. Interestingly, the higher the dose of Phonska fertilizer, the lower the soil pH compared to the effect of a low Phonska NPK dose (0 kg ha-1) (Fig 3 and Table 4). In comparison to the initial soil pH of 6.18 (Table 1), the soil pH at 45 DAP was generally lower. The application of Phonska fertilizer had a significant effect on LAI, while OLFC and the interaction between the two treatments had no significant influence on the LAI or the 100-seed weight of maize. The Leaf Area Index reflects the amount of sunlight penetrating the leaf surface, which is influenced by the leaf arrangement pattern. Therefore, LAI provides an overview of the photosynthetic and assimilate activity produced by plants to generate components for the growth and production of maize.

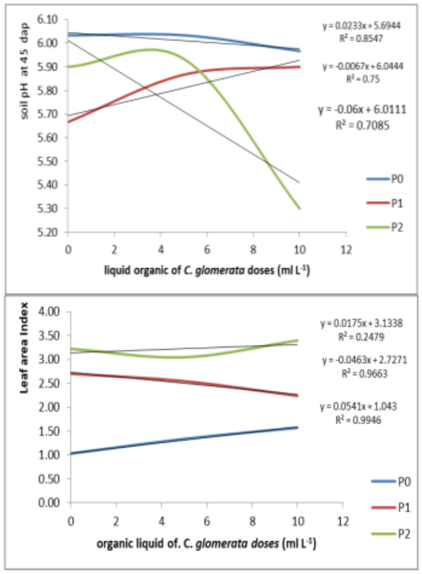

Figure 3. soil pH (1) and LAI (2) affected by Phonska NPK and OLFC

Table 4. Effect of OLFC application and NPK- Phonska on the soil pH, weight of 100 seeds and LAI at 45 DAP of maize

NPK Phonska (kg ha^{-1})	Soil pH	LAI	weight of 100 seeds (g)
0	6.01	1.31 b	20.42a
150	5.81	2.50 ab	21.60a
300	5.71	3.22 a	21.86a
CC (%)	4.70	18.65	7.15
LSD.05		0.59	

Numbers followed by the same uppercase letters in the same rows and lowercase letters in the same columns are not considered statistically significant according to the LSD at a 5% level.

3.5 The Yield and Agronomic Efficiency of Maize Plants

The single-factor application of Phonska and OLFC significantly increased the maize yield, as presented in Fig 4 and the accompanying Table 5. The highest yield, amounting to 5.03 tons ha^{-1}, was obtained from the application of 300 kg ha^{-1} Phonska, and this was not significantly different from the treatment with a dose of 150 kg ha^{-1} Phonska. Similarly, there was no significant difference in yield between the concentrations of 5 and 10 ml L^{-1} OLFC.

Fertilization efficiency, evaluated in terms of agronomic efficiency, can be determined by calculating nutrient uptake or agronomic components. Fertilization efficiency becomes evident upon analyzing the maize yield production data, as shown in Fig 4 and Table 5. While the dose of 300 kg ha^{-1} Phonska NPK resulted in a higher maize yield than that of 150 kg ha^{-1} Phonska NPK, the difference was not statistically significant. The administration of 5 ml L^{-1} OLFC was found to be the optimal dose. The highest agronomic efficiency from OLFC application occurred at the 150 kg ha^{-1} NPK Phonska level, reaching 11.275%. However, when the NPK dose was increased to 300 kg ha^{-1}, the fertilization efficiency decreased to 8.45%. In contrast, maize plants treated with OLFC exhibited a different trend. Applying 5 ml L^{-1} resulted in the highest efficiency, reaching 21.81%. However, with an increase in OLFC dose to 10 ml L^{-1}, agronomic efficiency decreased to 12.71%.

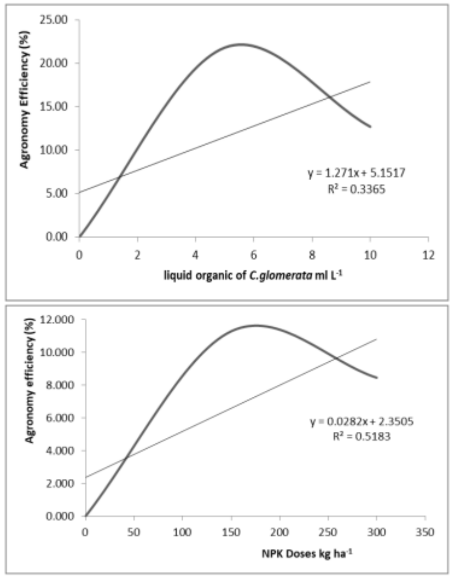

Figure 4. The relationship between the application of OLFC to fertilization efficiency from the agronomical characteristics of the application of liquid fertilizer or NPK Phonska fertilizer

Table 5. Effect of OLFC application and Phonska NPK fertilizer on maize yield weight and fertilization efficiency

Phonska NPK ($kg\ ha^{-1}$)	yield ($tonnes\ ha^{-1}$) OLFC ($ml\ L^{-1}$)				Fertilizr Efficiency Phonska NPK (%)
	0	5	10	Average	
0	2.14	3.42	3.87	3.14 b	0.000
150	4.32	5.45	4.73	4.83 a	11.275
300	4.83	5.69	6.50	5.67 a	8.446
Average	3.76 B	4.85 A	5.03 A		
Efficiency OLFC (%)	0.00	21.81	12.71		
CC (%)		14.77%			
LSD.05		0.67			
LSD.01		0.91			

Numbers followed by the same uppercase letters in the same rows and lowercase letters in the same columns are not considered statistically significant according to the LSD at a 5% level.

3.6 Discussions

Similarly, the treatment with 10 ml L^{-1} OLFC resulted in the highest maize kernel weight, reaching 5.03 tonnes ha^{-1}, and this was not significantly different from the maize yield obtained from the 5 ml L^{-1} OLFC treatment. Both of these treatments did not demonstrate a significant interaction with the results of dry-shelled maize. When assessed based on fertilization efficiency. The highest efficiency was observed with the application of 150 kg ha^{-1} NPK Phonska and 5 ml L^{-1} OLFC, as detailed in Table 5 and Fig 4. The peak fertilization efficiency was achieved with the application of 150 kg ha^{-1} Phonska NPK fertilizer, resulting in 11.275%, and 5 ml L^{-1} OLFC, reaching 21.81%. It is noteworthy that [18] demonstrated, in the context of maize, that applying a 300 kg ha-1 NPK Phonska dose could enhance the growth and yield of high-quality sweet maize, assessed based on its fresh weight. Additionally, [19] reported that maize yield could potentially reach an average of 7.7 tonnes ha-1 for hybrid varieties. The average production of hybrid maize varieties, as described, was 8.1 tonnes ha^{-1}. However, the results of this experiment did not achieve the productivity outlined for hybrid maize, which is significantly influenced by soil fertility.

The soil used in this experiment was alluvial with a moderate fertility rate and belongs to the Cambisol order. Nevertheless, it is important to note that the organic matter content in the soil was very low. The results of the soil analysis in Table 1 show that the soil contained high nutrients, including 0.32% N-total (moderate), 36.62 ppm available-P (very high), 18.59 me/100 g K (very high), 22.75 me/100 g Ca (very high), 19.75 me/100 g Mg (very high), and 11.09 me/100 g Na (very high), with a pH of 6.18 (slightly acidic) and organic –C 1.026 (low) [20]. Low soil organic matter can contribute to soil compaction, restricting root penetration and limiting the plant's access to nutrients and water. The changes in soil pH after planting maize, particularly with increasing doses of NPK (see Table 4), can further exacerbate these challenges, resulting in somewhat hindered plant height growth. Moreover, alterations in soil pH can significantly influence maize plant development.

The application of NPK Phonska and OLFC fertilizers to the soil used for maize cultivation led to a decrease in soil pH (Table 4). As highlighted by [21] and [22], plants tend to lower the soil pH around their roots during growth and development. This phenomenon is attributed to the release of organic acids and amino acids from plant roots into the soil. These acids react with minerals in the soil, producing hydrogen ions (H+), which are acidic cations. (Bashir et al., 2020) explained that with an increase in the concentration of hydrogen ions (H+) in the soil, the pH tends to decrease. Consequently, prolonged cultivation leads to a lower pH due to the increased release of hydrogen ions by maize. If the soil pH becomes excessively low, it can lead to issues such as nutrient deficiencies and heavy metal toxicity, adversely affecting plant growth. [23] and [24] underscored the importance of enhancing fertility in alluvial soil, especially when nutrients are scarce, particularly in alluvial soil with very low organic carbon content (C-organic).

It is suspected that nutrients in alluvial soil may not be readily available, leading to suboptimal nutrient absorption by plants. Therefore, it is crucial to provide adequate fertilization to alluvial soil, using the right types of fertilizers, namely NPK Phonska and OLFC. The effectiveness of inorganic fertilizers is expected to increase when accompanied by the application of OLFC fertilizers. OLFC fertilizer, derived from C. glomerata algae, contains lower nutrient levels compared to the original algae, except for a 0.14% increase in phosphorus content. According to [25] and [26] C. glomerata is rich in various vitamins, ranging from 2-5%, including vitamins A, B1, B2, B3, B5, B6, B9, C, and E. Chladophora glomerata also contains a diverse array of minerals, constituting 5-15%, such as calcium, potassium, magnesium, phosphorus, iron, and zinc.

Plants that received higher levels of nutrition from the NPK Phonska and OLFC treatments exhibited optimal growth in height, as indicated in Table 2 and Fig 1. The increase in plant height is expected to result in a higher NAR, RGR, and LAI. Interestingly, the application of 5 ml L-1 OLFC also demonstrated optimal average NAR and RGR, as depicted in Fig 2 and Table 2. This aligns with the achievement of optimal agronomic efficiency in corn plants treated with 5 ml L-1 OLFC. Particularly, when no NPK Phonska fertilizer is applied (0 kg ha^{-1}), the plant height does not reach 100 cm. In comparison, based on the description of the maize variety planted, the height has the potential to reach 222 cm [27]. This underscores the importance of optimizing nutrient levels, especially those classified as high to very high, to ensure optimal nutrient absorption by maize plants. If maize can optimally absorb nutrient levels classified as high to very high, these plants will certainly grow well and align with the previously described characteristics [28]. The alluvial soil used in this research was previously a paddy field. The land had undergone intensive application of inorganic fertilizers, resulting in soil chemical levels categorized as high to very high (refer to Table 1). In the case of applying 0 ml L^{-1} OLFC, there was a linear increase in plant height growth with a highly significant correlation ($R = 0.99$) whenever the Phonska dose was increased (refer to Fig 1 and Table 3). However, when OLFC was applied at doses ranging from 5 to 10 ml L^{-1}, the increase in maize plant growth exhibited a quadratic relationship. This indicates that the addition of OLFC enhances plant growth when accompanied by the application of Phonska fertilizer. Therefore, the application of both NPK Phonska fertilizer and OLFC is necessary for maize to achieve optimal growth.

Plants that grow taller will produce more leaves, thereby affecting the total leaf area, and subsequently increasing the LAI, NAR, and RGR of maize plants. A higher LAI indicates that the resulting plant assimilation will be higher, further influencing production or yield. According to [29], an LAI greater than 3 indicates that 95% of sunlight is absorbed by the leaves. However, if the LAI exceeds 5, absorption decreases due to leaf overlapping or shading. This occurs when plants are densely packed, either due to narrow spacing or rapid leaf development, causing overshadowing. LAI values are also significantly determined by leaf size and exposure to sunlight. The highest dose of Phonska NPK received by the leaves increased leaf size, resulting in a wider LAI of 3.22. This optimized photosynthetic activity compared to plants receiving 0-150 kg ha^{-1} of Phonska NPK fertilizer, with an LAI ranging from 1.31 to 2.50. In comparison to other studies, [30] tested chicken manure up to a maximum dose of 10 tonnes ha-1 for sweet maize, resulting in an LAI of 2.71. [31] applying cow manure, achieved a maize LAI of 2.25. [32] obtained maize LAI values of 2.45 and 0.41, respectively, using 7.5 tonnes ha-1 of manure and a spacing of 25 x 40 cm, along with basic fertilizers. These values are still lower than the results of this study. However, when maize plants were arranged in 75 x 25 x 25 cm and given 300 kg ha-1 N, the LAI reached 3.08 [33].

However, when applying 300 kg ha-1 Phonska NPK fertilizer, increasing the OLFC dose linearly increases the NAR of maize, with a correlation value (R) = 1 (refer to Fig 2). Comparing this with previous research conducted by [34] on maize, it was observed that as maize matures, the NAR of plants also increases. [35] reported that the NAR of maize in the age range of 21-28 DAP was approximately 20-40 mg cm^{-2} day^{-1}, while at 28-35 dap, it increased to around 40-50 mg cm^{-2} day^{-1}. Similarly, reports from [31] indicated that the NAR of maize ranged from 1.8-2.19 mg cm^{-2} day^{-1} at 14-28 dap, and at 28-42 DAP, it was obtained at 0.9-1.2 mg cm^{-2} day^{-1}. The Net Assimilation Rate is closely related to photosynthetic activity. A higher NAR corresponds to increased photosynthate production. Elevated photosynthate levels are indicative of well-functioning photosynthetic activities, commencing with the fixation of CO_2 in maize and its conversion into glucose, essential for optimal growth and the development of maize seeds.

The RGR serves as an indicator of how rapidly a plant has grown over a specific period and how it has grown relative to its current size. A higher RGR value signifies a faster growth rate for the organism. However, it is essential to note that RGR solely provides information on growth velocity concerning the plant's initial size and does not offer insights into the quality of growth or the health of the plant. As demonstrated by [36] the RGR values ranging from 98-102 mg g^{-1} day^{-1} were associated with maize yields reaching 8-9.23 tonnes ha^{-1}. In comparison, when examining the RGR values presented in Table 3, it is evident that only around 30% of the RGR achievement from the aforementioned report was attained.

Plants that absorb large amounts of nutrients will inevitably need additional nutrients to maintain their nutritional balance. Plants that receive optimal amounts of nutrients will experience a faster increase in the RGR than those that don't receive optimal nutrition. According to [37], one of the commonly used analytical tools for characterizing plant growth is the RGR, and its value can vary for each maize plant under different conditions. This variation has been reported by [38], showing that purple grain maize under salinity conditions exhibits an RGR ranging from 30-80 mg week-1 or 4.2 mg-11.42 mg day^{-1}. Additionally, [34] found that maize treated with organic substances at the age of 28-35 DAP had an RGR ranging from 2.45-4.41 mg day^{-1}, representing an increase of 1.8 times compared to that at younger ages (21-28 DAP). [39] reported that the RGR of maize plants ranges from 10-50 g m^{-2}. Another study by [40] demonstrated that the RGR of maize plants can reach 180 mg g^{-1} day^{-1}.

In this case, it is demonstrated that OLFC cannot completely replace the role of Phonska fertilizer in plants. However, OLFC can enhance plant growth even more when plants receive their basic nutrient requirements from Phonska fertilizer. [20] have also explained that inorganic fertilizers are crucial to meet the basic nutritional requirements of plants, but the incorporation of organic fertilizers and soil improvement materials can enhance the efficiency of these inorganic fertilizers. Previously, studies by [41] and [42] demonstrated that OLFC can increase growth and yield when accompanied by basic NPK fertilizer. [43] demonstrated that the application of a dose of 300 kg ha^{-1} NPK Phonska could increase the growth and yield of the highest sweet maize. The evaluation was based on the fresh weight of sweet maize. [44] reported that the yield of maize can reach 7.7 tonnes ha^{-1}. The average production of hybrid maize varieties, as described, was 8.1 tonnes ha^{-1}. The high yield of maize is influenced by several parameters. Before this treatment, there was a positive impact on LAI, the relative growth rate, the net assimilation rate, and the weight of 100 maize seeds.

4. CONCLUSIONS

The research presented indicates the impact of different fertilizer treatments on maize growth and yield, particularly focusing on the interaction between NPK Phonska fertilizer and OLFC (Chladophora glomerata algae-derived fertilizer). Here's a summary of the key findings and implications: 1) The treatment with 10 ml L^{-1} OLFC resulted in the highest maize kernel weight, comparable to the yield obtained from the 5 ml L^{-1} OLFC treatment. However, neither treatment significantly interacted with the results of dry-shelled maize. The highest fertilization efficiency was observed with the application of 150 kg ha^{-1} NPK Phonska and 5 ml L^{-1} OLFC; 2) The study utilized alluvial soil with moderate fertility but low organic matter content. Soil analysis revealed high nutrient levels but low organic carbon content, indicating potential limitations in nutrient availability for plants; 3) Application of NPK Phonska and OLFC fertilizers led to a decrease in soil pH. Low soil pH can hinder plant growth by affecting nutrient availability and potentially causing toxicity issues; 4) OLFC fertilizer, although containing lower nutrient levels compared to the original algae, can enhance plant growth when accompanied by NPK Phonska fertilizer. Its application showed quadratic relationships with maize plant growth, emphasizing its role in optimizing growth when combined with inorganic fertilizers; 5) Higher levels of nutrition from NPK Phonska and OLFC treatments resulted in optimal plant growth in terms of height, LAI, NAR, and RGR. A linear increase in NAR was observed with increasing OLFC dose when applying 300 kg ha^{-1} Phonska NPK fertilizer. Plants that absorb optimal nutrient levels exhibit faster growth rates, as indicated by RGR values. The study underscores the importance of maintaining a nutritional balance to support rapid and healthy plant growth. OLFC can enhance plant growth when combined with basic nutrient requirements from NPK Phonska fertilizer. While inorganic fertilizers are crucial for meeting basic plant nutritional needs, the incorporation of organic fertilizers like OLFC can enhance their efficiency. In conclusion, the research highlights the importance of optimizing fertilizer application, particularly the synergistic effects of combining inorganic and organic fertilizers, to enhance maize growth and yield in alluvial soil conditions. Additionally, it underscores the significance of maintaining soil fertility and pH balance for optimal plant nutrition and productivity.

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REFERENCES

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