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# Effect of liquid organic fertilizer on soils to evaluate growth rate and leaf yield of Lemongrass (*Cymbopogon citratus*) in Abraka, Delta State, Nigeria

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**ABSTRACT:** Lemongrass (*Cymbopogon citratus*) is underexploited specie among the *Poaceae* family. Unknown to many people, it is peculiar because of its medicinal properties but there is dearth of information on the modalities for enhancing its growth and leaf yield. Hence, the objective of this paper was to investigate the Effect of liquid organic fertilizer (LOF) on soils to evaluate growth rate and leaf yield of Lemongrass (*Cymbopogon citratus*) in Abraka, Delta State, Nigeria using appropriate procedures. Results obtained showed that lemongrass that received LOF significantly increased plant height (cm) from 128.4 to 142.2, while plants that did not receive LOF (control) had plant height of 68.4cm to 76.2cm. The fresh weight of leaves for increased growth of lemongrass also increased from 486.2g/plant to 520.6g/plant, while the dry weight of leaves in g/plant increased from 126.2 to 140.6 as a result of application of LOF. The outstanding performance of plants that received LOF against their control counterparts could be attributed to additional supply of nutrients to the soil by LOF.

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Lemongrass (*Cymbopogon citratus*) is a native aromatic crop grown in many parts of tropical and sub-tropical South East Asia and Africa (Spriha and Anupam, 2021). It is a perennial and herbaceous plant with a stout, erect culm up to 1.8 meters high with long, glaucous, green, linear leaves narrowing at one end upwards and along the margins. Native to Pakistan, India and Sri Lanka (Manzoo *et al.,* 2013), Lemongrass has been regarded as a home remedy to certain ailments because of its high antioxidant, aromatic qualities and high nutritional values (Manzoo *et al.,* 2013).Hanna *et al.,* (2012) and Santin *et al*., (2005) reported that lemongrass possesses anti-inflammatory properties, reduces the risk of cancer, promotes healthy digestion, regulates cholesterol level, relieves symptoms of painful menstruation as well as act as a diuretic which aids the body to get rid of excess fluid and sodium. Majewska *et al.*,(2019) reported that the lemon-scented plant adds favour to soups, curries, teas and other beverages. *C. citratus* is generally used in folk medicine for treatment of gastrointestinal disturbances, and as analgesic, antispasmodic, antipyretic, anti-inflammatory, sedative and diuretic activity (Santin *et al.,* 2009; Wifek *et al.,* 2016). Extracts from *C. citratus* leaves have demonstrated the antioxidant, antifungal and antimicrobial actions (Hanna *et al.,* 2012). Lemon grass has variety of significance in different pharmaceutical industries for its anti-depressant, analgesic, antipyretic, bactericidal, antiseptic,

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carminative and astringent properties (Wifek *et al.,* 2016). Biologists posited that the oil of lemon grass could be used for the treatment of different ailments such as toothaches and headaches as well as insect repellant and diuretic agent for fever (Wifek *et al.,* 2016). Lemongrass can grow well at a temperature of 10 – $35^0$C with enough sunlight (Tajidin *et al.,* 2012;Olorunnisola *et al.,* 2013), rainfall of 700 – 3000mm which spread evenly throughout the year (Sumiartha*et al.,* 2009). It strives on soil pH of 5 – 7. Lemon grass contains many useful chemical compounds such as saporin, fluvonoids, polypheroids, alkaloids and essential oil with citral and geranial which have antibacterial properties (Khasanah*et al.,* 2010). The best time to harvest lemongrass is 6.5 – 7months after planting when the contents of citral(geranial) is adequately found in the grass crop (Tajidin *et al.,* 2012; Olorunnisola *et al.,* 2013). Citral is used as a raw material for the production of ionone, vitamin A and beta carotene (Pavian*et al.,* 2006).

Inspite of the increasing relevance of lemongrass, its production has greatly been limited by continuousdecrease in soil fertility caused by annual bush burnings and terrestrial rains which predispose farmlands to erosion and leaching of mineral nutrients away from rooting zones. Liquid organic fertilizer has been reported to have enhanced the growth and yield of some crops. Microsoft Corporation (2003) posited that LOF acts as substrate for micro-organisms whose activities enhance germination, growth, early maturity and yield of benefitting crops. Al-Shujiuiry and Al-Hadethi (2025) reported that application of 100ml of LOF significantly increased leaf area, chlorophyll content, stem diameter, shoot length and dry weight of leaves of local lemon trees. Owomubi *et al.,* (2021) reported that liquid organic fertilizer increased the number of leaves, plant height and number of branches of waterleaf. Astiari *et al.,* (2024) reported that liquid organic fertilizer promoted early flowering, number of fruits per plant, fruit diameter and fruit weight of *Siamese citrus*. Aluko *et al.,* (2021) reported that SuperGrow liquid organic fertilizer significant increased the plant height, number of leaves, leaf Area and overall fruit yield of cucumber. Abobatta and El-Azazy (2020) reported that organic and biofertilizers increased availability of nutrients in soil, promoted the population of microflora, reduced the harmful effects of pathogenic organisms, improved plant tolerance to biotic and abiotic stresses and enhanced the eventual yield in *Citrus orchards*. Although, mineral fertilizers have been reported to boost the yield of crops, they are costly and inaccessible to peasant farmers. They are also corrosive and exhibit hazardous effects on the soil. Organic manures such as poultry, cattle and pig manures produce offensive odour apart from being bulky to transport to distant farmlands. Consequently, Hence, the objective of this paper was to investigate the Effect of liquid organic fertilizer (LOF) on soils to evaluate growth rate and leaf yield of Lemongrass (*Cymbopogon citratus*) in Abraka, Delta State, Nigeria.

## MATERIALS AND METHOD

*Description of experimental site:* The study was carried out in the Experimental Farm of Delta State University, Abraka in 2023 and repeated in 2024. Abraka is located between Latitude $6^04^0$E and Latitude $5^054^0$N where the rainy season begins in April and terminates in October, while the dry season starts in November and ends in March. The rainfall (mm) is between 2000 and 3000, while the temperature ranges from $25^0$ – $31^0$C (Aruegodore, 2003).

*Land preparation and soil analysis:* The land measuring 98.64$m^2$was cleared with cutlass and tilled using hoe. Fifteen plots measuring 90cm x 90cm which were marked out using a measuring tapeconstituted a replicate. Three replicates were involved, and each replicated was separated by 1m part way while each pot was separated from the other by 45cm spacing. The net area of the experiment was 60.37$m^2$, while 38.27$m^2$ was the discard area. By means of a sampling auger, surface soils (10 – 15cm) were collected from the plots, bulked together, air-dried at room temperature of $27^0$C for three days, after which it was crushed and filtered using a 2mm sieve. Using the hydrometer method, particle size distribution was determined as recommended by Gee and Bauder (1986). A pH meter (Pyellnican Model $MK^2$) was used to ascertain the pH in a 1 : 2 : 5 water suspension ratio. Organic carbon was determined using Walkey-Black wet oxidation method recommended by Nelson and Sommer (1982). Total nitrogen was assessed using the Micro-Kjedahl distillation techniquedescribed by Bremiuer and Mulvancy (1982), while Available phosphorus was assessed following Bray No 1 Method of IITA (1979). A flame photometer was used to know the Exchangeable potassium. The Cation Exchange Capacity (CEC) was indicated through the Ammonium acetate saturation method of Raades (1982).

*Collection of root cuttings and planting:* Root cuttings of 5cm length were collected from well-established stalk at Ministry of Agriculture and natural Resources Farms, Asaba, Delta State and

planted in the plots at a spacing of 90cm x 90cm and a depth of 2.5cm under rainfed condition.

*Composition and Dilution rate of liquid organic fertilizer:* According to Dambara and Green Planet International (2003) Powerplant LOF contains plant extracts, Humic acids, Seaweed, amino acids and NPK (4-0-6.5) meaning 4% nitrogen (N), 0% phosphorus (P) and 6.5% water soluble potassium oxide. The liquid organic fertilizer was diluted at the ratio of 60ml of fertilizer to 15 litres of water as recommended, and applied to the topsoil according to the treatment using a hand sprayer.

*Weeding:* The plots were kept weed-free through the experimental period.

*Data Collection:*
Data collected were germination percentage, plant height, leaf area and weight of leaves.
*Germination Percentage:* Data on germination percentage was collected 4 weeks after planting the root cuttings using equation 1:

$$GP = \frac{No.of\ Germinated\ Root\ Cuttings}{Total\ No.of\ Root\ Cuttings\ Planted} * \frac{100}{1} \quad (1)$$

*Plant Height:* Plant height of the sample population investigated at 6, 12 and 18 weeks after sowing was obtained by using tape rule to measure from the base of the plant to the tip of the growing seedling according to the treatments.

*Leaf area:* The leaf area was estimated by measuring the length and breadth of the plant and multiplying the answer obtained by a correction factor of 0.75 using equation 2(Agbogidi *et al.,* 2007).
LA = Length x Breath x 0.75 (2)

*Weight of Fresh Leaves:* This was obtained by measuring it with a weighing scale.

*Data Analysis:* Data collected were subjected to analysis of variance and significant means were separated using Duncan Multiple Range Test (DMRT) according to SAS (2000).

## RESULTS AND DISCUSSION

*Pre-planting Soil Analysis:* The pre-planting soil analysis is shown in Table 1. The particle size fractions indicate that the soils were sandy loam with low organic matter of 13.6gkg$^{-1}$ and total nitrogen of 0.86gkg$^{-1}$. Soil pH was slightly acidic (6.3), while available phosphorus was low with value of 5.30mgkg$^{-1}$. Water soluble potassium was equally low (.17cmolkg$^{-1}$). The values obtained in this analysis were all low based on FMANR (1996) ratings for the ecological zone. The low fertility status of the soil could be attributed to the effects of torrential rainfall which causes erosion and leaching common in ultisols of humid areas with strongly weathered low activity clay minerals that cause high acidity (Enujeke and Anwuli-Okoh, 2024).

**Table 1:** Pre-planting soil analysis of the experimental site:

| Parameters | Values obtained |
|---|---|
| **Particles size fractions (%)** | |
| Sand | 85.3 |
| Silt | 9.8 |
| Clay | 4.9 |
| Textural class | Sandy loam |
| pH ($H_2O$) | 6.3 |
| Organic matter (gkg$^{-1}$) | 13.6 |
| Total Nitrogen (gkg$^{-1}$) | 0.86 |
| Available P (mgkg$^{-1}$) | 5.30 |
| Exchangeable K (cmolkg$^{-1}$) | 0.17 |
| CEC (cmolkg$^{-1}$) | 10.18 |

Legend: % = Percentage, gkg$^{-1}$ = gram per kilogram, mgkg$^{-1}$ = milligram per kilogram, cmolkg$^{-1}$ = centimole per kilogram

*The effects of four different application rates of LOF on germination percentage of root cuttings and plant height of Lemongrass:* The effects of four different application rates of LOF on germination percentage of root cuttings and plant height of Lemongrass is shown in Table 2. There were significant differences in germination percentage and plant height of lemongrass as affected by LOF during both years of investigation. In 2023, increased application of LOF resulted in corresponding increases in germination percentage of the roots cuttings. Plants that received 15 lha$^{-1}$ of LOF had highest germination percentages of 92.0% and 96.0% in 2023 and 2024, respectively against their control counterparts which had the lowest germination percentages of 72.0% and 76.0% in both years. With respect to plant height, plants that received 15 lha$^{-1}$ of LOF had the highest plant heights at 6, 12 and 18 weeks after planting, with values of 80.6cm, 104.2cm and 128.4cm, while plant in the control plot (0 lha$^{-1}$) had the lowest plant heights of 42.4cm, 54.2cm and 68.4cm at 6, 12 and 18 weeks after planting respectively. Similar trend was observed in 2024 when highest application rate of 15 lha$^{-1}$ of LOF gave a corresponding highest plant height of lemongrass at 6, 12 and 18 weeks after planting (98.4cm, 124.2cm and 142.2cm respectively). Also, plants that did not receive LOF had the lowest plant height of 56.2cm, 64.4cm and 76.2cm at 6, 12 and 18 weeks after planting respectively. This is similar to the findings of Enujeke and Anwuli-Okoh (2024); Enujeke and Ogbinaka (2025) who reported that highest application rate of LOF resulted in corresponding highest growth of Soursop (*Annona muricata*). It is also consistent with the findings of Oroka and

Ureigho (2019) who reported increased growth in early seedling morphology of *Irvingia wombolu*.

*Effects of four different application rates of LOF on leaf area of lemongrass:* The effects of four different application rates of LOF on leaf area ($cm^2$) of lemongrass in 2023 and 2024 planting seasons is showing in Table 3. Significant differences were observed in leaf area of the grass crop in both seasons. In 2023, plants that received LOF application rate of 15 $lha^{-1}$ were outstanding in leaf area at 6, 12 and 18 weeks after planting with values of 36.0$cm^2$, 37.5$cm^2$ and 45.0$cm^2$, respectively. It was followed by plants that received LOF application rate of 10 $lha^{-1}$ with leaf area in $cm^2$ of 31.5, 33.8 and 40.5. Plants that received LOF application rates of 0 $lha^{-1}$ had the lowest leaf area of 22.5$cm^2$, 26.3$cm^2$ and 31.5$cm^2$ at 6, 12 and 18 weeks after planting respectively. In 2024, similar trend was observed, where plants that received 15 $lha^{-1}$ of LOF had the highest leaf area ($cm^2$) of 33.8, 39.4 and 45.0 at 6, 12 and 18 weeks after planting. Also, plants in the control plot which received 0 $lha^{-1}$ of LOF had the smallest leaf area of 26.3cm, 33.8cm and 36.0cm. Also the order of superiority in leaf area based on litre / hectare of LOF received was 15>10> 5 > 0. The superiority of 15 $lha^{-1}$ over other rates could imply that it was the most appropriate rate that satisfied the soil requirement for increased growth parameter of lemongrass in the ecological zone. This is consistent with the reports of Mehedi *et al.,* (2012) and Enujeke *et al.,* (2022) which posited that highest manure application rates give corresponding increases in growth characters of benefiting crops

**Table 2:** Effects of four different application rates of LOF on germination percentage of root cuttings and plant height (cm) of lemongrass:

| Parameter | Germination percentage | | | Plant height | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2023 | | | | 2024 | | | |
| | 2023 | 2024 | Mean | 6 | 12 | 18 | Mean | 6 | 12 | 18 | Mean |
| **Rate of LOF $lha^{-1}$** | 72.0$^{d}$ | 76.0$^{d}$ | 74.04 | 42.4$^{d}$ | 54.2$^{d}$ | 68.4$^{d}$ | 55.0$^{d}$ | 56.2$^{d}$ | 64.4$^{d}$ | 76.2$^{d}$ | 65.6$^{d}$ |
| 0 | | | | | | | | | | | |
| 5 | 82.0$^{c}$ | 84.0$^{c}$ | 83.0c | 54.6$^{c}$ | 68.4$^{c}$ | 88.2$^{c}$ | 70.4$^{c}$ | 70.4$^{c}$ | 84.0$^{c}$ | 98.4$^{c}$ | 84.3$^{c}$ |
| 10 | 86.0$^{b}$ | 90.0$^{b}$ | 88.0b | 70.4$^{b}$ | 82.0$^{b}$ | 106.6$^{b}$ | 86.3$^{b}$ | 86.6$^{b}$ | 100.4$^{b}$ | 120.0$^{b}$ | 102.3$^{b}$ |
| 15 | 92.0$^{a}$ | 96.0$^{a}$ | 94.0a | 80.6$^{a}$ | 104.2$^{a}$ | 128.4$^{a}$ | 104.4$^{a}$ | 98.4$^{a}$ | 124.2$^{a}$ | 142.2$^{a}$ | 121.6$^{a}$ |
| Mean | 83.0 | 86.5 | | 62.0 | 77.2 | 97.9 | | 77.9 | 93.3 | 109.2 | |

**Table 3:** Effects of four different application rates of LOF on leaf area of lemongrass:

| | 2023 | | | | 2024 | | | |
|---|---|---|---|---|---|---|---|---|
| | Weeks after planting | | | | Weeks after planting | | | |
| **Parameter** | **6** | **12** | **18** | **Mean** | **6** | **12** | **18** | **Mean** |
| **Rate of LOF $lha^{-1}$** | 22.5$^{d}$ | 26.3$^{d}$ | 31.5$^{d}$ | 26.8$^{d}$ | 26.3$^{d}$ | 33.8$^{d}$ | 36.0$^{d}$ | 32.0$^{d}$ |
| 0 | | | | | | | | |
| 5 | 26.3$^{c}$ | 30.0$^{c}$ | 36.0$^{c}$ | 30.8$^{c}$ | 30.0$^{c}$ | 37.5$^{c}$ | 40.5$^{c}$ | 36.0$^{c}$ |
| 10 | 31.5$^{b}$ | 33.8$^{b}$ | 40.5$^{b}$ | 35.3$^{b}$ | 37.5$^{b}$ | 41.3$^{b}$ | 49.5$^{b}$ | 42.8$^{b}$ |
| 15 | 36.0$^{a}$ | 37.5$^{a}$ | 45.0$^{a}$ | 39.5$^{a}$ | 41.3$^{a}$ | 45.0$^{a}$ | 54.0$^{a}$ | 46.8$^{a}$ |
| Mean | 29.1 | 31.9 | 38.3 | | 33.8 | 39.4 | 45.0 | |

**Table 4:** Effects of four different application rates of LOF on fresh and dry weights of leaves of lemongrass:

| | Fresh weight of leaves (g/plant) | | | Dry weight of leaves (g/plant) | | |
|---|---|---|---|---|---|---|
| **Parameters** | **2023** | **2024** | **Mean** | **2023** | **2024** | **Mean** |
| **Rate of LOF $lha^{-1}$** | | | | | | |
| 0 | 280.2 | 322.4 | 301.3 | 64.6 | 72.4 | 67.5 |
| 5 | 342.6 | 398.2 | 370.4 | 82.4 | 94.2 | 88.3 |
| 10 | 410.4 | 466.2 | 438.3 | 98.6 | 118.4 | 108.5 |
| 15 | 486.2 | 520.6 | 503.4 | 126.2 | 140.6 | 133.4 |
| Mean | 379.85 | 426.85 | | 92.95 | 106.4 | |

*Effects of Four Different Application Rates of LOF on Fresh and Dry Weight of Leaves of Lemongrass:* The effects of four different application rates of LOF on fresh and Dry weight of leaves of lemongrass (g/plant) in 2023 and 2024 is shown in Table 4. Plants that received highest application rate (15 $lha^{-1}$) of LOF had the highest fresh weight of leaves in both years of evacuation (486.2 g/plant) and 520.6g/plant,

respectively while plants that did not receive LOF (0 $lha^{-1}$) had the lowest fresh weight of leaves (g/plant) of 280.2 and 322.4, respectively. Similar trend was observed in the estimation of Dry weight of leaves (g/plant). In 2023 and 2024, plants that received highest application rate of LOF had a corresponding highest Dry weight of leaves of 126.2g/plant and 140.6g/plant, respectively while plants that received 0 $lha^{-1}$ of LOF had the lowest Dry weight of leaves (g/plant) of 64.6 and 72.4, respectively. The order of superiority of plants that received litre per hectare of LOF with respect to fresh and dry weight of leaves (g/plant) was 15> 10 > 5 > 0. The outstanding performance of plants that received 15 $lha^{-1}$ of LOF could be attributed to preponderance of nutrients released by this highest rate of application over the rates. This implies that 15 $lha^{-1}$ satisfied the soil requirement for increased growth and leaf yield of lemongrass in that agro-ecological zone. This is similar to the findings of Enujeke and Anwuli-Okoh (2024) who reported that highest rate of goat manure gave highest yield of Christmas melon. It is also similar to the findings of Astiari *et al.*, (2024) and Aluko *et al.*, (2021) who reported that LOF promoted early flowering, number of leaves, leaf area and yield of benefiting crops. It is also consistent with the report of Microsoft Corporation (2003) which posited that LOF acts as substrate for microorganism whose activities enhance germination, growth and yield of crops.

*Conclusion:* Liquid organic fertilizer mineralized to enhance soil nutrient status, growth parameters and leaf yield of lemongrass. The present study has contributed to knowledge by ascertaining the most appropriate rate of LOF suitable for the study area, hence it was recommended for adoption by farmers in order to improve soil fertility and desired qualities of the test crop.

*Declaration of interest:* The authors declare that no known conflict of interest or personal relationships that could have influence the work reported in this paper.

*Declaration of Data Availability:* Data are available upon request from the corresponding author or first author.

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