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Sugarcane mud press as nutrient supplement for tomato (*Lycopersicon esculentum*)

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Abstract

The study was designed to assess the efficacy of mudpress as nutrient supplement for tomato production and its effect on soil chemical properties. Specifically, it aimed to analyze the change in nutrient content of soil and to evaluate the growth and productivity of tomatoes as affected by the application of mudpress. The study was established at Battung, Tuao, Cagayan from November 2023 to March 2024. The following treatments were: Control (T1), 100-30-30 kg NPK (T2), 100-30-30 kg NPK + 5 bags Mudpress (T3), 100-30-30 kg NPK + 10 bags Mudpress (T4), 100-30-30 kg NPK + 15 bags Mudpress (T5) and 10 bags Mudpress (T6) arranged in RCBD with three replications. The application of mudpress regardless of amount improves the soil pH, availability of phosphorous, and exchangeable potassium of the soil compared to control plots. It was also observed that the addition of mudpress as supplement to inorganic fertilizer based on soil recommendation improves the plant height of tomato in all observation periods. The yield and yield components of tomato was also increased by the application of mudpress. The additional application of 10-15 bags of mudpress along with the full recommended rate of inorganic fertilizer is recommended to farmers since the said material is readily available in the municipality of Piat and can be used to increase the yield of tomato growers within the area.

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Introduction

Philippines is endowed with many various resources; hence farming is considered to be the main source of living of the majority of the population. The country produces rice, corn, coconut, sugarcane, poultry, and hogs as the primary contributors to biomass energy resources. The increase in production also has a direct relationship with the volume of agricultural wastes produced in the production system. Agricultural waste can be in the form of animal manures, crop left-overs after harvest, and even the weeds which proliferate within the area of production.

The Philippines is one of the highest producers of agricultural waste. Based on the theoretical and technical residue volume of major crops in the Philippines which was adopted from Tadeo (2015), sugarcane production was recorded to have reached 22, 370, 546 metric tons and with an estimated value of 1.17 million metric tons of sugarcane waste which can be utilized as biomass resource. In addition, 6.16 million tons of bagasse is still available waste products from the 29 operating sugar mills in the entire country. The Sugarcane Regulatory Administration (SRA, 2015) claims that they are hard up in disposing of sugarcane waste including filter cake/mudcake, bagasse, mud press and other sugarcane waste by products.

In accordance with the implementing rules and regulation (IRR) of the Republic Act 9003 also known as the Ecological Waste Management Act of 2009, burning of agricultural waste is strictly prohibited except when the said waste material was infected with virus, bacteria or any disease-causing organism that needs to be disposed based on the existing waste disposal protocols. To utilize the available agricultural waste products, the birth of organic agriculture is timely since one of its mandates is to transform the conversion of agricultural by-products into concoctions, growth promotants, soil conditioners and/or amendments, and even production of organic fertilizers. The Cagayan Robina Sugar Corporation (CARSUMCO) was established at Sto. Domingo, Piat, Cagayan and produce much of sugarcane milling wastes which must be decomposed, recycled, and plowed back into the production system for proper utilization. Crop residues are readily available for recycling for the proper utilization of macro and micro nutrients present in the material (Dotaniya *et al.,* 2016). Sugarcane mud press is generated from milling industries and can improve the soil's physical, chemical, and biological properties which later lead to higher crop yield (Ghulam *et al.,* 2012). This is the reason why the researcher would like to utilize the full potential of the sugarcane mud press as a nutrient supplement in the production of tomato especially in areas nearby the milling district.

Tomato is one of the most indispensable high-value crops in the Philippines. Its high demand and the insufficient supply in the local market made its price prohibitive. Tomato production fits well in areas that are usually rich with organic matter and well-drained soil across the regions of the country. It should be noted that majority of tomato produced are intended for processing (Agong *et al.,* 2001). Since, there is dearth of information on the appropriate amount of mud press for the production of tomato, this study was then designed to assess how tomato respond to increasing levels of sugarcane mud press, hence this study.

The study was designed to evaluate the efficacy of mud press as nutrient supplement for tomato production and its effect on soil chemical properties. Specifically, it aimed to: (1) analyze the change in the nutrient content of soil applied with mud press; (2) evaluate the growth improvement of tomato grown to soil amended with mud press; and (3) determine the productivity of tomatoes applied with sugarcane mud press.

Materials and methods

Collection of mud press

Mud press was collected at the dumped site of Universal Robina Corporation (URC). The mud press which was collected from the site must be fully decomposed. This can be determined by its black and porous color and must not produce a foul odor. The material must not also produce high temperature to be considered as fully decomposed material. One (1) kilogram of the mud press was brought to the Integrated Laboratory Division of DA Region 02 for analysis of pH, organic content, total nitrogen, available phosphorous, exchangeable potassium, and micronutrients.

Soil sampling

Soil sampling was done by collecting samples in ten (10) different locations of the experimental field. Samples was air-dried and was submitted to the Cagayan Valley Agricultural Integrated Laboratory (CVIAL) for analysis. The report of the analysis was used as the basis in drawing the different fertilizer dressings.

Collection of soil samples and analysis

Soil samples were collected randomly from the experimental area before and after the conduct of the experiment. The soil samples were processed by pulverizing, air drying, grinding, and screening. A one-kilogram of the composite soil sample was set aside and was also submitted at the Integrated Soils Laboratory – Cagayan Valley Research Center, City of Ilagan, Isabela for the analysis of pH, OM, P, K, and micronutrients.

Securing of planting materials

Planting materials was provided by the Department of Agriculture Regional Office 02 under the High-Value Crops Program (HVCP). A request letter was sent to their office at least one (1) month prior to the conduct of the study.

Land preparation

The experimental area consisting of 720 m^2 was prepared by plowing and harrowing with at least one (1) week intervals. This was undertaken to attain good soil tilth and aeration to facilitate planting and to ensure better crop growth and development. An elevated experimental plot measuring 4 meters by 5 meters was constructed to accommodate the different treatment combinations. Drainage was made to avoid rotting of plants, especially during heavy downpour of rain.

Experimental design and treatments

The experiment was laid out using the Randomized Complete Block (RCB) design to test the following treatments:

Treatment 1- Control

Treatment 2- Recommendation Rate

Treatment 3- Recommendation Rate (Inorganic) + 0.5 RR Sugarcane Mud press

Treatment 4- Recommendation Rate (Inorganic) + 1.0 RR of Sugarcane Mud press

Treatment 5-Recommendation Rate (Inorganic) + 1.5 RR of Sugarcane Mud press

Treatment 6- Recommendation Rate of Sugarcane Mudpress.

An alleyway of one (1) meter in between replications and treatments was provided to facilitate the performance of cultural management activities.

Seed sowing

Seeds was sown in seedling trays to minimize transplanting shock and to avoid overcrowding of seedlings. The growing media composed of carbonized rice hull, garden soil and compost in equal proportion was mixed properly and sterilized to avoid the occurrence of a soil-borne pathogen. Planting seedlings in the seed tray also ensures a complete crop stand.

Transplanting

Transplanting was done at least 28 days after seed sowing or when plants have at least five (5) true leaves. This was done late in afternoon to minimize transplanting shock.

Plants was spaced 50 cm in between hills and 1m apart in between furrows at one (1) seedling per hill.

Mulching

Rice straw was used as mulching materials. This was undertaken by evenly spreading dried rice straws over the experimental plots with a thickness of 3-5 cm to minimize soil moisture losses and growth of weeds.

Fertilizer application

The kind and amount of fertilizers applied in each of the specified treatments were based on the result of soil analysis. Organic fertilizer materials were basally applied inorganic fertilizers were applied on a staggered basis i.e., during transplanting, 15 and 30 days after transplanting but still following the soil recommendation.

Water management

Irrigation was done as the need arises using equal amount of water per plant to minimize bias results.

Pest management

Hand-picking and spraying of double-action insecticides was done to control the occurrence of insect pests during the conduct of the study.

Priming

Priming was done when the crop shows mature yellow-green to red fruits. A total of eight (8) priming's was considered in the experiment. Plants in the harvest area of each plot was used to determine the agronomic characteristics and yield and yield parameters. Plants in the edges of rows and those planted in the outer rows are excluded to minimize biased results.

Statistical Analysis

Data were analyzed using the Statistical Tool for Agricultural Research (STAR). The Analysis of Variance using Tukey's Honest Significance Difference (HSD) test at 5% and 1% was used to compare the significance of the treatments tested.

Results and discussion

Effect of mudpress on selected soil properties

Nutrient composition of mudpress

The mudpress was analyzed for pH, OM, P, K, and micronutrients and result is presented in Table 1. Based on the result, initial soil pH of 5.94 was obtained and was described as moderately acidic.

The mudpress had a moderate amount of organic matter content with 2.36 percent, and organic carbon of 1.36 percent. Organic matter acts a reservoir of nutrients and water within the soil, playing a vital role in reducing compaction and surface crusting while enhancing the water infiltration. Its presence contributes significantly to plant growth by influencing the soil's physical, chemical, and biological properties.

Total nitrogen is medium at 0.16 percent, phosphorus is 0.12 percent and potassium is 0.05 percent. Total NPK of the mudpress is 0.33 lower than the 5% required to be considered as organic (PNS for Organic Fertilizer). The C/N ratio of the product is 8.5 C g^{-1} N which is considered low and implies that the product is preferable and acceptable, as ratio below 20 is an indicative of an acceptable maturity, while ratio of 15 or even less is preferable (Inbar *et al.*, 1990). The high C ratio suggest that the mudpress and subsequent soil organic matter fractions are characterized by low carbon content and high nitrogen levels.

Table 1. Nutrient composition of mudpress.

Chemical Properties			Description
Ph	(%)	5.94	Moderate
Organic Matter	(%)	2.36	Medium
Organic Carbon	%	1.36	Medium
Nitrogen	(%)	0.16	Medium
Available Phosphorus	(%)	0.12	Very high
Exchangeable Potassium	(%)	0.05	High
Magnesium	(%)	0.22	High
Calcium	(%)	15.55	High
Zinc	ppm	26.5	High
Copper	ppm	14.5	High
Manganese	Ppm	83.13	High

The amount of biomass generated by the mudpress, along with C ratio and management practices, will influence the potential increase in soil organic matter. Additionally, the mudpress contains Cu (14.50 ppm), Zn (26.50 ppm), and Mn (83.13 ppm), and likely harbors several other micronutrients not accounted for in the analysis. These micronutrients typically aren't present in standard formulation of inorganic fertilizers available in the market.

Initial soil analysis

The initial soil analysis results for the experimental area are summarized in Table 2. The findings reveal a pH of 5.24, 1.53% organic matter content, 0.076% total nitrogen concentration, 2.46 ppm available phosphorous, and 55.66 ppm exchangeable potassium. These values collectively indicate that the experimental site is characterized by strong acidity and low organic matter levels. Moreover, the total nitrogen content is notably low, accompanied by very limited availability of phosphorous and exchangeable potassium.

Effect of mud press on soil pH

Table 2 also shows the pH level of the soils amended with mudpress. The amended soils exhibited a notably higher soil pH compared to the soil sample in the control group. From the soil pH of 5.99 in the control, the mudpress application intervention improves the soil pH from 6.26 to 6.46.

The result jives with the study of Pandian *et al.* (2006) who found out that, mudpress could raise soil pH from 5.7 to 6.3 of a soil grown to peanut.

Table 2. Soil pH as influenced by mudpress application.

TREATMENTS		Soil pH
T_1	Control	5.99 b
T_2	100-30-30 kg NPK ha^{-1}	6.32 a
T_3	100-30-30 kg NPK + 5 bags Mudpress	6.64 a
T_4	100-30-30 kg NPK + 10 bags Mudpress	6.59 a
T_5	100-30-30 kg NPK + 15 bags Mudpress	6.26 a
T_6	10 bags Mudpress ha^{-1}	6.62 a

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

In this study, it showed that the addition of mudpress improved the soil pH of the acid soil. This property of mudpress is important to increase the soil CEC (cation exchange capacity) when mudpress is added to soil. The liming power of mudpress depends basically on its ashes content, which is not really mudpress but one of its fractions (mineral fraction). The liming effect of the mudpress depends on its bases content (Ca, Mg, K and Na). Some mudpress has high ash content but sometimes not too much bases, but Si (as some grass) or Fe (if the feedstock is contaminated by soil or sediments).

Table 3. Organic matter content (%) of soils as influenced by mudpress application.

TREATMENTS		OM (%)	Nitrogen (%)
T_1	Control	1.59	0.08
T_2	100-30-30 kg NPK ha^{-1}	1.74	0.09
T_3	100-30-30 kg NPK + 5 bags Mudpress	2.67	0.13
T_4	100-30-30 kg NPK + 10 bags Mudpress	2.73	0.14
T_5	100-30-30 kg NPK + 15 bags Mudpress	2.35	0.12
T_6	10 bags Mudpress ha^{-1}	2.65	0.13

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

Effect of mudpress on soil organic matter

Mudpress application showed no significant improvement in terms of organic matter content, likewise the nitrogen contents of the soils with approximately 0.516 units (Table 3).

The findings of the study contradicts numerous previous studies that have consistently demonstrated the efficacy of mudpress in enhancing and sustaining soil organic matter level, especially in long term cultivated soils within subtropical and tropical regions (Chan *et al.*, 2007, 2008; Deenik *et al.*, 2011; Van Zwieten *et al.*, 2010). Moreover, mudpress application did not improve the nitrogen contents of the amended soil which differ with the control by approximately 0.028 units, respectively. The result suggests that mudpress have no profound effect on the organic matter of the soil. Likewise, it had no significant effect on the enhancement of soil nitrogen.

Effect of mudpress on available phosphorus

The mudpress regardless of amount significantly enhanced the availability of phosphorus in the amended soils. Table 4 shows the change in the phosphorus contents of soils amended with mudpress.

Table 4. Available phosphorus (ppm) of soils as influenced by mudpress application.

TREATMENTS		Avail. P (ppm)
T_1	Control	31.28 d
T_2	100-30-30 kg NPK ha^{-1}	43.46 cd
T_3	100-30-30 kg NPK + 5 bags Mudpress	64.50 bc
T_4	100-30-30 kg NPK + 10 bags Mudpress	74.18 ab
T_5	100-30-30 kg NPK + 15 bags Mudpress	89.42 a
T_6	10 bags Mudpress ha^{-1}	31.30 d

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

Results revealed that addition of 15 bags of mudpress in addition to inorganic fertilizer increased the phosphorus content of the soil by 89.42 ppm considered the highest, this was followed by the 10 bags mudpress with 78.14 ppm, 5 bags mudpress by 64.50 ppm, and mudpress alone by 31.30 ppm.

In general, the application of mudpress has the potential to improve the availability of phosphorus of an acidic soil. Based from the result, phosphorus availability in soil could be enhanced with mudpress application regardless of feedstock source. Results indicated that mudpress were able to bring available phosphorus into soils, but the amount and form of available P were dependent on mudpress types (Alloway, 2008). Phosphorous plays a crucial role in plant function as it aids in converting other nutrients into usable building blocks essential for growth.

As one of the primary nutrients, phosphorous is integral to various physiological processes within plants. Optimal phosphorous nutrition significantly boosts various facets if plant development, including flowering, fruiting, and root growth.

Table 5. Exchangeable potassium (ppm) of soils as influenced by mudpress application.

TREATMENTS		Exch. K (ppm)
T_1	Control	403.06 b
T_2	100-30-30 kg NPK ha^{-1}	508.87 ab
T_3	100-30-30 kg NPK + 5 bags Mudpress	596.99 ab
T_4	100-30-30 kg NPK + 10 bags Mudpress	635.49 ab
T_5	100-30-30 kg NPK + 15 bags Mudpress	750.54 a
T_6	10 bags Mudpress ha^{-1}	443.01 b

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

Effect of mudpress on exchangeable potassium

Table 5 shows the potassium contents of the amended soils. Following the application of mudpress to the soils, the amended plots exhibited higher potassium levels, surpassing those of the control plot by a minimum of 750.54 ppm. From the original K level of 403.06 ppm, there was strong evidence that the mudpress application intervention improved the potassium availability in the soils.

The addition of 15 bags mudpress indicated the highest increase of potassium level with 750.54 ppm, followed by 10 bags mudpress with 635.49 ppm and 5 bags mudpress with 596.99 ppm. Mudpress alone increased the potassium level only by 443.01 ppm. In general, mudpress regardless of the amount increased the potassium contents of the acidic oil after 2 months of incubation. The study findings are somewhat in line with the research conducted by Lin *et al.* (2012), which suggested that mudpress could enhance nutrient availability. Mudpress was found to contain notable levels of available P (0.64 mg kg^{-1}), available K (711 mg kg^{-1}), available Na (1145 mg kg^{-1}), available Ca (5880 mg kg^{-1}), and available Mg (1010 mg kg^{-1}) (Masto *et al.*, 2013). Furthermore, addition of mudpress in a pot experiment to investigate effects of mudpress produced from corn cobs on some chemical properties and potassium status in a calcareous sandy soil resulted in significant increases ($P \leq 0.05$) in the soil pH, organic matter (OM), soluble potassium, and available potassium (Abu El-Eyuoon and Abu Zied Amin, 2016).

The application of mudpress to acidic red soil favored good soil physical, chemical, and biological environment; and these positive changes influenced growth and yield attributes and enhanced pod yield 29% over control (Pandian *et al.*, 2006).

Table 6. Micronutrient Composition of Soil applied with Mudpress for 3 months.

TREATMENT	Chemical Properties			
	Cu	Fe	Mn	Zn
T1 – Control	4.79	49.50	19.73 bc	1.25 c
T2 - 100-30-30 kg NPK ha^{-1}	4.69	47.30	21.00 b	1.77 b
T3 - 100-30-30 kg NPK + 5 bags Mudpress	4.51	48.83	26.27 ab	2.23 ab
T4 - 100-30-30 kg NPK + 10 bags Mudpress	4.86	52.17	29.33 a	2.20 ab
T5 - 100-30-30 kg NPK + 15 bags Mudpress	4.73	50.90	29.53 a	3.13 a
T6 - 10 bags Mudpress ha^{-1}	4.49	48.17	12.73 c	1.60 bc

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

Effect of mudpress on micronutrients

Table 6 shows the micronutrients contents of the amended soils after 2-month incubation. Result revealed that mudpress application has little potential to improve the availability of copper and iron contents of the soil. The addition of 15 bags mudpress indicated the highest increase of manganese level with 29.53 ppm, followed by 10 bags mudpress with 29.33 ppm and 5 bags mudpress - with 26.27 ppm. Mudpress alone increased the potassium level only by 12.73 ppm. For zinc, addition of 15 bags mudpress indicated the highest increase of manganese level with 3.13 ppm, followed by 10 bags mudpress with 2.20 ppm and 5 bags mudpress - with 2.23 ppm. Mudpress alone increased the potassium level only by 1.60 ppm. In general, regardless of the amount of mudpress increased the manganese and zinc contents of the acidic soil after mudpress application.

Effect of mudpress on tomato productivity

Plant height

At 30, 45 and 60 DAT, the height of tomato applied with mudpress is presented in Table 7. At 30 DAT, the average plant height is 58.67 cm with means varied among each other at 2.56 percent. Data showed that the plants applied with 100-30-30 kg NPK plus 15 bags mudpress (T_5) were the tallest at 109.52 cm, followed by 100-30-30 kg NPK plus 10 bags mudpress (T_4) with 102.98 cm, and 100-30-30 kg NPK plus 5 bags mudpress (T_3) with 92.50 cm, but comparable to the plants applied with RR NPK (T_2) with mean of 89.52 cm. Sole application of mudpress significantly improved the height of the plants as evident by the taller plants compared to the control.

Table 7. Plant Height (cm) of Tomato as Affected by Mudpress.

TREATMENTS	Plant Height (cm)		
	30 DAP	45 DAP	60 DAP
T1 – Control	75.72 e	95.45 d	144.35 d
T2 - 100-30-30 kg NPK ha^{-1}	89.52 c	124.41 b	167.40 b
T3 - 100-30-30 kg NPK + 5 bags Mudpress	92.50 c	131.65 b	175.10 b
T4 - 100-30-30 kg NPK + 10 bags Mudpress	102.98 b	144.74 a	175.17 b
T5 - 100-30-30 kg NPK + 15 bags Mudpress	109.52 a	152.76 a	199.23 a
T6 - 10 bags Mudpress ha^{-1}	83.51 d	108.69 c	157.62 c
C.V. (%)	2.56	4.25	2.45

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

At 45 DAT, application of 100-30-30 kg NPK plus 15 (T5) and 10 (T4) bags mudpress indicated the tallest plants at 152.76 and 144.74 cm, respectively. Application of 10-15 bags as addition to RR NPK significantly enhanced plant growth. These were followed by the plants applied it 100-30-30 kg NPK plus 5 bags mudpress (T3) with mean height of 131.65 cm, but did not vary with the reference check (T2) with 124.41 cm. A different result was obtained a 60 DAT, where the plants supplied with 15 bags mudpress along with full RR of NPK were the tallest at 199.23 cm. This was followed by the plants which received 5 to 10 bags of mudpress with 100-30-30 kg NPK with 175.10 and 175.17 cm, respectively. These two, however, did not vary with the reference check of 100-30-30 kg NPK. This result implies that 15 bags of mudpress was able to affect the heoght growth of the tomato plants t 65 DAT. Lowering the rate to 5 to 10 bags showed no significant effect on the plant heights. Sole application of mudpress indicated plant height of 157.62 cm, which were taller than the untreated control with 144.35 cm. Such differences in the plant height between T_6 (mudpress) and T_1 (control) were attributed to the organic fertilizers applied.

Table 8. Number of Marketable and Non-marketable Fruits per Plant.

TREATMENTS	Number of Fruits	
	Marketable	Non-marketable
T1 - Control	32.59 e	5.25 a
T2 - 100-30-30 kg NPK ha^{-1}	45.30 c	3.25 bc
T3 - 100-30-30 kg NPK + 5 bags Mudpress	47.40 bc	3.50 abc
T4 - 100-30-30 kg NPK + 10 bags Mudpress	51.75 ab	2.25 c
T5 - 100-30-30 kg NPK + 15 bags Mudpress	53.35 a	2.25 c
T6 - 10 bags Mudpress ha^{-1}	38.80 d	5.00 a
C.V. (%)	5.60	22.21

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

The available nutrients present in the organic fertilizer play important role in the growth of tomato. Mineralization of the mudpress releases nutrients to soil; thereafter, available to the plant. In some studies, soil amended with organic fertilizer had a higher organic C and total N (Laudicina and Badalucco, 2023).

Number of marketable and non-marketable fruits per plant

Table 8 shows that significant result was obtained in terms of the number of marketable fruits per plant. The plants applied with 100-30-30 kg NPK with 15 bags mudpress (T5) and 10 bags mudpress (T4) produced the greatest number of fruits per plant with a mean value of 53.35 and 51.75, respectively. The latter however, is comparable to the plants applied with 100-30-30 kg NPK with 5 bags mudpress (T3) with 47.40. The effect of adding 5 bags mudpress, however, proved to be non-significant as indicated by the non-significant variation of means with the reference control (T2) with mean of 45.30. Sole application of 10 bags mudpress produced more fruits than the untreated control with 32.59 considered the least. The result conforms to the previous researches which proved that mudpress contains a substantial number of humic acids that produced significantly more fruits and flowers (Aroncon *et al.,* 2006).

The significant inherent phosphorus content in the soil treated with mudpress contributed to enhanced responsiveness of tomato plants, resulting in improved fruiting, vigorous root growth and development, and overall crop maturity (Singh *et al*, 2019). Furthermore, the high availability of exchangeable potassium provided a sufficient supply during the growth period, thereby enhancing water relations in plants and facilitating photosynthesis. The increased number of marketable fruits observed in plants treated with both inorganic fertilizer and mudpress can be attributed to the presence of ample macro and micronutrients necessary for normal growth and development. Overall, the enhanced growth and yield of plants can be due to the high availability of both macro and micro nutrient content in the soil.

Table 9. Weight of marketable fruits per plant (kg).

TREATMENTS	Weight of marketable fruits per plant (kg)
T1 – Control	2.24 d
T2 - 100-30-30 kg NPK ha^{-1}	2.96 b
T3 - 100-30-30 kg NPK + 5 bags Mudpress	3.24 a
T4 - 100-30-30 kg NPK + 10 bags Mudpress	3.48 a
T5 - 100-30-30 kg NPK + 15 bags Mudpress	3.54 a
T6 - 10 bags Mudpress ha^{-1}	2.51 c
C.V. (%)	8.87

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

The number of non-marketable fruits per plant revealed significant result based on the analysis of variance. The plants in the control plots (T_1) produced the greatest number of non-marketable fruits with a mean value of 5.25. However, the plants treated with mudpress alone (T6) had comparable mean of 5.00 fruits.

Weight of marketable fruits per plant

The effect of the application of mudpress on the weight of marketable fruits per plant is presented in Table 9. Result showed significant variation among treatment means. The plants treated with 100-30-30 kg NPK plus 5, 10 and 15 bags of mudpress produced comparable weights of fruits per plants which are considered the heaviest fruits with a mean value of 3.24, 3.48 and 3.54 kg, respectively.

These were significantly higher than the fruits obtained from the reference plot (T2) with 2.96 kg. The sole application of 10 bags mudpress on plants produced fruits with mean weight of 2.51 kg/plant. The lightest fruit yield was obtained from the plants in the untreated control (T_1) with a mean value of 2.24 kg. According to Canellas *et al.* (2022) and Atiyeh *et al.* (2000), improvement of yield is due to plant growth regulators released by the microbes and humates of mudpress.

Number of marketable fruits per sampling area

A similar trend of result was observed in terms of the number of marketable fruits per sampling area (Table 10). The plants applied with 100-30-30 kg NPK + 15 bags Mudpress (T5) and 100-30-30 kg NPK + 10 bags Mudpress (T4) produced the greatest number of marketable fruits per plant with a mean value of 1878 and 1820, respectively. However, the latter was comparable to 100-30-30 kg NPK + 5 bags Mudpress (T3) with mean of 1651. This implies that addition of 10-15 bags of mudpress to the recommended rate of NPK could improve the fruiting ability of the tomato plants, and addition of 5 bags mudpress showed similar effect with 10 bags. The sole application of mudpress at 10 bags per hectare produced more fruits than the control, which indicate that mudpress alone has the potential as nutrient source of tomato.

Table 10. Number of Fruits per sampling area (4 m²).

TREATMENTS	Number of Fruits per Sampling Area (4 m²)
T1 – Control	1,093 e
T2 - 100-30-30 kg NPK ha^{-1}	1,522 c
T3 - 100-30-30 kg NPK + 5 bags Mudpress	1,651 bc
T4 - 100-30-30 kg NPK + 10 bags Mudpress	1,820 ab
T5 - 100-30-30 kg NPK + 15 bags Mudpress	1,878 a
T6 - 10 bags Mudpress ha^{-1}	1,333 d
C.V. (%)	5.87

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

Projected yield

The computed yield per hectare as influenced by application of the fertilizers and mudpress is presented in Table 11. The yields of the different treatments were presented in descending order: Treatment 5= 4.87-ton, Treatment 4= 4.32 ton, Treatment 3 = 4.20 ton, Treatment 2 = 4.03 ton, Treatment 6 = 3.31 ton, and Treatment 1 = 2.33 ton.

In terms of percent increase in yield with the reference check (T_2) as the basis, the use of inorganic NPK plus 15 bags mudpress (T_5) manifested a yield increment of 20.84 percent. Reduction of the application rate at 10 bags per hectare increased the yield by 7.20 percent, while lowering further to 5 bags per hectare revealed yield increase of 4.22 percent. The sole application of 10 bags per hectare of mudpress is attributed to a yield increase of 42.06 percent with respect to the control plots. This implies that application of mudpress as add on to inorganic fertilizer can improve yield by at least 4.22 to 20.84 percent. The application of mudpress at 15 bags per hectare in addition to inorganic NPK is effective in enhancing the yield performance of tomato.

Table 11. Fruit Yield.

TREATMENTS	Fruit Yield	
	Kg/20 m²	ton/ha
T1 - Control	4.66 d	2.33
T2 - 100-30-30 kg NPK ha^{-1}	8.06 b	4.03
T3 - 100-30-30 kg NPK + 5 bags Mudpress	8.39 b	4.20
T4 - 100-30-30 kg NPK + 10 bags Mudpress	8.64 ab	4.32
T5 - 100-30-30 kg NPK + 15 bags Mudpress	9.73 a	4.87
T6 - 10 bags Mudpress ha^{-1}	6.61 c	3.31
C.V. (%)	4.97	---

Means with common letters are not significantly different with each other using Tukey's HSD at 1% level.

The result suggest that the application of inorganic fertilizers combined with 5-10 bags of mudpress yields comparable results to the recommended rate of inorganic fertilizer (100-30-30 kg NPK), highlighting the importance of proper crop management for maximizing tomato yield. Significant improvements in tomato yield attributed to the application of inorganic fertilizer, providing readily available nutrients crucial for fruit formation and development, thereby enhancing yield (Shukla *et al,* 2013).

In this study, balanced application of inorganic fertilizer alongside 15 bags of mudpress led to increased tomato yield compared to untreated control plants (T1) and those with 5-10 bags of mudpress (T3 and T4). Patil *et al.,* (2013) similarly found that the use of bio-fertilizers in combination with sugar press mud (SMP) enhanced soil macro and micronutrient levels, favoring both vegetative and reproductive growth of crops, consequently boosting overall crop yield.

Conclusions and recommendations

Base on the result of the study, the chemical analysis of the organic fertilizer utilized in the exeriment unveiled that mudpress exhibited a pH of 5.94 classified as moderately acidic. The mudpress had a moderate amount of organic matter content with 2.36 percent, and organic carbon of 1.36 percent. Total nitrogen is medium at 1.36 percent, phosphorus is 0.12 percent and potassium is 0.05 percent. Total NPK of the mudpress is 0.33 which is below the 5% requirement for a material to be considered as organic (PNS for Organic Fertilizer). The experimental field exhibited strong acidity and low organic matter. Total nitrogen levels were low with limited availability of phosphorous and exchangeable potassium. From the soil pH of 5.99 in the control, the mudpress application intervention improves the soil pH from 6.26 to 6.46. Mudpress application showed no significant improvement in terms of organic matter content, likewise the nitrogen contents of the soils with approximately 0.516 units. The mudpress regardless of amount significantly enhanced the availability of phosphorus in the amended soils. After applying mudpress to the soils, the amended soils had significantly higher exchangeable potassium contents by at least 750.54 ppm than the control plot. Mudpress application significantly improved the height growth of the plants. Plants applied with mudpress at 15 bags plus 100-30-30 kg NPK (T5) were the tallest at 109.52 cm, 152.76 cm and 199.23 cm, at 30, 45 and 60 DAT, respectively. The plants applied with 100-30-30 kg NPK with 15 bags mudpress (T5) and 10 bags mudpress (T4) produced the greatest number of fruits per plant with a mean value of 53.35 and 51.75, respectively. The plants in the control plots (T_1) produced the greatest number of non-marketable fruits with a mean value of 5.25. The plants treated with 100-30-30 kg NPK plus 5, 10 and 15 bags of mudpress produced comparable weights of fruits per plants which are considered the heaviest fruits with a mean value of 3.24, 3.48 and 3.54 kg, respectively. The highest projected fruit yield was attained from plants applied with 100-30-30 kg NPK with 15 bags mudpress (T5) and 10 bags mudpress (T4) with 4.87 and 4.3 t/ha, respectively. The result of the experiment proved the potential of mudpress affect significantly the soil chemical properties, growth and yield of tomato. The application of 10-15 bags as addition to the recommended rate of inorganic fertilizer had the greatest impact on the growth and yield of tomato. The use of mudpress in the production of tomato is recommended to farmers for sustainable agriculture. Plants treated with 10-15 bags of mudpress produced the highest fruit yield hence, it is recommended for tomato production.

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