

Jatropha Foliage Sustains Soil Nutrients Level And Grain Yield Of Pearl Millet In Sudan Savannah (Nigeria)

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Abstract

Field experiments were conducted in the year 2020 and 2021 rainy seasons to evaluate the soil nutrients level and grain yield of pearl millet in response to *Jatropha* foliage (organic soil amendment), at Kadawa (11.650° N and 8.450° E) Nigeria, where accessibility and affordability of fertilizer is difficult to low income farmers who cultivate crops on low fertility soils. To improve the fertility of the soils, there is need to apply large amounts of organic materials such as *Jatropha* foliage, which is a cheap and available resource in the study area. The treatments were: T1 (control), T2 (5 t/ha *Jatropha* foliage), T3 (10 t/ha *Jatropha* foliage) and T4 (Full recommended rate of fertilizer) arranged using Randomized Complete Block Design (RCBD) with 3 replications. From 2020 to 2021, there were increases in mean Organic Carbon (0.36-0.46%), Available Phosphorus (5.45-10.01 mg/kg), exchangeable Potassium (0.12-0.14 cmol/kg) and Grain yield (1684.6-1741.8 kg/ha). These increases were attributed to the carryover effect of nutrients from previous year's application (2020-2021 wet seasons). Application of 10t/ha *Jatropha* foliage significantly increased the grain yield by 34.2-44.6% over control treatment. The full recommended rate of fertilizer (Full-RF) was significantly superior to the 10 t/ha rate of *Jatropha* foliage in improving the grain yield of pearl millet by 81.1-83.2%. However, inorganic fertilizer caused a decline in soil available P, exchangeable K, CEC and pH. Therefore, application of *Jatropha* foliage is recommended to sustain soil fertility and grain yield of pearl millet in the Nigerian Sudan Savannah.

Keywords: Soil fertility, Sustain, Carryover effects, Foliage, Fertilizer.

INTRODUCTION

Pearl millet is an important crop in the arid and semi-arid parts of the world where more than 100 million people consume it as staple food in Africa and Asia [1]. The crop is nutritious and contains about 72% starch, 12% protein, 6.1% fat and 7.6% dietary fibre. It also contains good amounts of minerals and vitamins such as Phosphorus (341 mg), Iron (17 mg), Calcium (37 mg) and traces of Molybdenum, Nickel, Vanadium, Manganese, Iodine, Zinc, Copper, Chromium, Cobalt and Barium [2]. However, low soil fertility has been identified as a major factor that limits the productivity of the crop [3,4]. In the last 5 decades, FAO [5] reported the relative low yield of the crop (0.8 t/ha) when compared with maize (4.0 t/ha), rice (3.8 t/ha) or sorghum (1.5 t/ha).

The role of *Jatropha* (*Jatropha curcus* L.) in relation to plant and soil development has been documented by many researchers [6,7,8,9]. Most of the works have focused on *J. curcus* as a biofuel crop while detailed studies of *J. curcus* foliage as a soil amendment in pearl millet production are limited despite the fact that many low income farmers fence their small farms with *Jatropha* plants and the crop (pearl millet) is widely grown and consumed in the Sudan Savannah zone of Nigeria, where most of the farmers have little income, hence accessibility and affordability of mineral fertilizers is indeed difficult. That was why this study tried to determine the effect of *Jatropha* foliage (as a soil amendment) on the maintenance of soil nutrients level and grain yield of pearl millet in the Sudan Savannah zone of Nigeria.

MATERIALS AND METHODS

The field trials in 2020 and 2021 rainy seasons were conducted at Kadawa demonstration farm, Nigeria (11.650° N and 08.450° E with elevation of 502 m). The area is located within the Sudan Savannah of Nigeria with annual rainfall of approximately 700 mm (long term average). Throughout the year, average temperature is mostly warm or hot at approximately 25±7° C [10]. Soil and plant analyses were conducted using standard methods. The soil was classified by Soil Survey Staff [11] as Inceptisol (Tropcept), with high sand content, low organic carbon, low available phosphorus, low CEC and slightly acidic pH (Table 1).

Jatropha foliage was characterised for chemical content (Table 2). Soil samples were obtained from a depth of 0-20 cm (zig-zag pattern). Soil samples from each plot were mixed together to obtain one composite sample. Each composite sample was air-dried, and then crushed to pass through a sieve (2 mm in diameter). Thereafter, 3 sub-samples were analysed for selected soil properties. Soil particle size distribution was by the hydrometer method after Calgon® was used as a dispersant. The textural class was determined from USDA soil textural triangle. Soil pH was measured with pH meter using a soil/solution ratio of 1:2.5. Soil Organic Carbon (SOC) was determined by using the modified Walkley and Black method [12]. Determination of Total Nitrogen (TN) was by the microkjeldahl procedure after wet oxidation of soil organic matter whereby free NH₃ was liberated by steam distillation in excess alkali. Thereafter, the distillate was obtained in a container that was having excess boric acid with an indicator of pH = 4.5. The TN was then measured by titration procedure [13]. Available phosphorus (AP) was measured by using the Bray 1. method (0.025N HCl plus 0.03N NH₄F) as outlined by Bray and Kurtz [14]. The exchangeable cations were determined by using 1N ammonium acetate at pH = 7. Potassium and sodium ions were measured by flame emission spectroscopy while calcium and magnesium ions were determined by atomic absorption spectroscopy. The Effective Cation Exchange Capacity (CEC) was calculated by the summation of exchangeable bases and that of exchangeable acidity as outlined by Anderson and Ingram [15].

The foliage used was randomly obtained from ten Jatropha plants around the research farm, after on-set of the wet season. The Jatropha foliage was cut into smaller pieces to achieve homogenization. Foliage was thoroughly mixed and then air-dried for 20 days. Samples of the foliage were ground and passed through a 2mm sieve. Triplicate sub-samples were taken for determination of nutrients concentration. The TN was measured by microkjeldahl procedure [16] while the Total P was measured via wet digestion by using the vanadomolybdate phosphoric yellow colour procedure [16]. Potassium content was determined by using flame photometry after wet digestion [15]. Organic carbon was measured by using the ash method that was detailed by Okelabo *et al.* [17]. Determination of lignin was based on the acid detergent fibre procedure after boiling with H₂SO₄ and then lignin was removed by oxidation with a buffered permanganate solution. Determination of polyphenols was by using 50% methanol at about 80° C (with tannic acid as the standard solution) [15].

The field treatments were:

T1 - Control (without any Jatropha foliage or mineral fertilizer)

T2 - Surface applied Jatropha foliage (5 t/ha)

T3 - Surface applied Jatropha foliage (10 t/ha)

T4 – Full recommended rate of fertilizer (Full-RF)

Experimental design was the Randomised Complete Block Design (RCBD) with 3 replications. The Full-RF was 60 kg N/ha, 30 kg P₂O₅/ha and 30 kg K₂O/ha as outlined by Idem [18].

The foliage was surface applied by placing it on the furrows for 20 days before sowing pearl millet (Super Sosat variety). Gross plot size was 4.5 m by 6 m. Intra row spacing was 25 cm while inter row spacing was 75 cm. Nitrogen mineral fertilizers were split-applied (at 2 and 6 weeks after sowing). All the Phosphorus (P) and Potassium (K) mineral fertilizers were surface applied at 2 weeks after sowing. Pearl millet was harvested at physiological maturity. Harvest in each net plot was allowed to sun-dry for 25 days. Threshing and winnowing were carried-out to obtain clean grains. For each plot, grain yield was separately determined by weighing and then converting to kg/ha basis.

The ridges were remoulded at 6 weeks after sowing alongside the weeding. The first and second year experiments were conducted on the same site and the plots were maintained throughout the period of the study. In the second year, the plots were prepared manually to maintain plot properties. The old ridges were levelled with a hoe and the appropriate Jatropha foliage applied after ridging to place the amendment. All the other operations were carried out as in the first year.

Data analyses were conducted by using the Analysis of Variance (ANOVA) to determine statistical significance. Means were separated using the Least Significant Difference (LSD) test at $p < 0.05$. All data were analysed by the Statistical Analysis System (SAS) package, version 9.4

RESULTS

Soil and Jatropha Foliage in the Study Area

Analyses of the initial soil used are presented in Table 1. The soil is slightly acidic (pH_{water}: 6.2-6.3), low in available phosphorus (5.9-6.3 mg/kg), total nitrogen (0.04-0.08%), CEC (3.8-5.9 cmol/kg) and very low in organic carbon content (0.60-0.62%). The soil is highly likely to respond to fertilization due to low fertility status [19,20].

Table 1: Initial Physico-chemical properties of the soil at the experimental site

| Property | 2020 | 2021 |
|--|------------|------------|
| Sand (%) | 83±2.11 | 82±1.12 |
| Silt (%) | 14±1.78 | 14±0.97 |
| Clay (%) | 3±1.21 | 4±1.33 |
| Textural class | Loamy sand | Loamy sand |
| pH (water) | 6.3±0.09 | 6.2±0.07 |
| pH (0.01M CaCl ₂) | 5.3±0.04 | 5.2±0.05 |
| Organic carbon (%) | 0.62±0.16 | 0.60±0.07 |
| EC (dSm ⁻¹) | 0.04±1.18 | 0.05±1.18 |
| Total nitrogen (%) | 0.08±0.04 | 0.04±0.07 |
| Available P (mg kg ⁻¹) | 6.3±0.18 | 5.9±0.22 |
| Exch. Ca (cmol _c kg ⁻¹) | 2.1±0.08 | 4.0±0.09 |
| Exch. Mg (cmol _c kg ⁻¹) | 0.26±0.22 | 1.08±0.25 |
| Exch. K (cmol _c kg ⁻¹) | 0.15±0.04 | 0.08±0.13 |
| Exch. Na (cmol _c kg ⁻¹) | 0.17±0.11 | 0.06±0.08 |
| CEC (cmol _c kg ⁻¹) | 3.8±0.88 | 5.9±0.85 |
| Exch. H+Al (cmol _c kg ⁻¹) | 0.6±0.71 | 0.6±0.54 |

Values are means of triplicate samples (n=3) ±SE

Characterization of *Jatropha* foliage (Table 2) indicated that the soil amendment is suitable for direct application on the soil for annual crop production. Palm *et al.* [21] provided a guide on using different organic resources based on their quality in relation to C:N ratio, macronutrients, polyphenol and lignin content. From the guide, an organic material with greater than 2.5% total nitrogen content, less than 4% polyphenols and less than 15% lignin can be incorporated into soil for annual crops production. If an organic material has less than 2.5% total nitrogen and greater than 15% lignin, such a material is to be applied on soil surface for water conservation and erosion control. For an organic material that has greater than 2.5% total nitrogen and greater than 15% lignin or greater than 4% polyphenols, the material is to be mixed together with mineral fertilizer or a high quality organic matter. Those materials having less than 2.5% total nitrogen and less than 15% lignin content should be mixed together with mineral fertilizer or added to good compost.

Table 2: Chemical Concentration of the *Jatropha* foliage used

| Attribute | 2020 | 2021 | Reference |
|--------------------|-----------|-----------|-----------|
| Total carbon (%) | 44.6±0.07 | 43.5±0.02 | [17] |
| Total nitrogen (%) | 3.09±0.04 | 3.01±0.05 | [16] |
| Phosphorus (%) | 0.26±0.02 | 0.28±0.03 | [16] |
| Potassium (%) | 1.6±0.04 | 1.7±0.04 | [15] |
| C:N ratio | 14.4±0.05 | 14.4±0.04 | |
| Lignin (%) | 12.5±0.03 | 13.1±0.03 | [15] |
| Polyphenol (%) | 0.47±0.04 | 1.21±0.05 | [15] |

Values are means of triplicate samples (n=3) ±SE

Soil Nutrients Level (Year 2020 and 2021)

Soil organic carbon

Soil organic carbon (SOC) supports, maintains and improves soil fertility and productivity [22]. The effect of *Jatropha* foliage on soil organic carbon during 2020 and 2021 wet seasons is presented in Table 3.

Table 3: Effect of Jatropha foliage on soil organic carbon (%) in 2020 &2021

| Treatment | Year 2020 | Year 2021 |
|--------------------------|------------------|------------------|
| Control | 0.29c | 0.33d |
| 5 t/ha Jatropha foliage | 0.28c | 0.47b |
| 10 t/ha Jatropha foliage | 0.51a | 0.62a |
| Full-RRF | 0.36b | 0.43c |
| Mean | 0.36 | 0.46 |
| SE± | 0.01 | 0.01 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

From the result, mean organic carbon increased from 0.36-0.46% (2020-2021 seasons). This may be as a result of applying Jatropha foliage for 2 consecutive years. Moreover, application of 10 t/ha Jatropha foliage was found to be significantly superior to other treatments in improving the soil organic carbon (both years). In the year 2020, organic carbon content in treatments with 5 t/ha Jatropha foliage were statistically the same with the control treatment, while in 2021, the treatment with 5 t/ha Jatropha foliage was significantly superior to control treatment. This emphasizes the need to keep on adding organic matter to soils that have low amounts of such an important soil component, especially when the soil is sandy.

Soil available phosphorus

The available Phosphorus refers to the main forms of P taken up by plants [23]. It is a major limiting factor to pearl millet production [24,25].

Table 4: Effect of Jatropha foliage on soil available phosphorus (mg/kg) in 2020 &2021

| Treatment | Year 2020 | Year 2021 |
|--------------------------|------------------|------------------|
| Control | 3.75c | 6.85c |
| 5 t/ha Jatropha foliage | 6.85a | 6.84c |
| 10 t/ha Jatropha foliage | 5.41b | 9.72b |
| Full-RF | 5.79b | 16.65a |
| Mean | 5.45 | 10.01 |
| SE± | 0.12 | 0.07 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

Effect of Jatropha foliage on available Phosphorus (Table 4) showed that between 2020 and 2021, mean available Phosphorus increased from 5.45-10.01 mg/kg (83.7%). The application of inorganic fertilizer or 10 t/ha Jatropha foliage (Table 4) significantly increased available phosphorus in the soil by 187.6% (5.79-16.65 mg/kg) and 79.7% (5.41-9.7 mg/kg) respectively. The result of year 2021 showed that inorganic fertilizer was significantly superior to other treatments in increasing the available P of soil, while application of 10 t/ha Jatropha foliage significantly increased available P when compared to 5 t/ha rate of Jatropha foliage or the control treatment.

Soil exchangeable Potassium

From Table 5, mean exchangeable K increased (2020-2021 seasons) from 0.12 to 0.14 cmol_e/kg (16.7%). The availability of K to plants is related to its relative concentration to Mg and Ca. Magnesium induced K deficiency was reported for Southern Ethiopian soils [26]

Table 5: Effect of Jatropha foliage on soil exchangeable K (cmol_e/kg) in 2020 & 2021

| Treatment | Year 2020 | Year 2021 |
|-------------------------|------------------|------------------|
| Control | 0.11c | 0.16a |
| 5 t/ha Jatropha foliage | 0.14a | 0.12b |

| | | |
|--------------------------|-------------|-------------|
| 10 t/ha Jatropha foliage | 0.13ab | 0.17a |
| Full-RF | 0.12bc | 0.10b |
| Mean | 0.12 | 0.14 |
| SE± | 0.01 | 0.01 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

In the year 2021, 10 t/ha Jatropha foliage significantly recorded the highest exchangeable K. From 2020 to 2021, Full-RF and 5 t/ha Jatropha foliage recorded decreases in K, while control treatment and 10 t/ha Jatropha foliage treatments recorded increases in K. The result seems to be inconsistent due to problem of fixation and low solubility of K in soil [27].

Soil cation exchange capacity (CEC)

Cation exchange capacity is key to soil fertility. Higher CEC indicates more of the basic cations (Ca, Mg and K) in soil [27]. CEC values of <10 cmol_c/kg are low and can be found in sandy soils. However, organic matter greatly contributes to higher CEC in soils. Low CEC causes soils to be highly acidic hence requiring more liming [28]. The effect of treatments on soil CEC is presented in Table 6.

Table 6: Effect of Jatropha foliage on soil CEC (cmol_c/kg) in 2020 & 2021

| Treatment | Year 2020 | Year 2021 |
|--------------------------|-------------|-------------|
| Control | 3.7c | 4.7b |
| 5 t/ha Jatropha foliage | 5.1b | 4.8b |
| 10 t/ha Jatropha foliage | 5.6a | 7.3a |
| Full-RF | 4.8b | 4.1c |
| Mean | 4.8 | 5.2 |
| SE± | 0.22 | 0.11 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

From 2020 to 2021, the mean CEC (Table 6) increased by 8.3% (4.8 to 5.2 cmol_c/kg). The main increase is attributable to the application of 10 t/ha Jatropha foliage which improved CEC from 5.6 to 7.3 cmol_c/kg (30.4%). Organic matter is reported to contribute 30-70% of the total CEC in soil [29]. In both years, 10 t/ha Jatropha foliage was found to be significantly superior to the other treatments in improving the soil CEC. Result of 2021 indicated that mineral fertilizer significantly recorded the lowest CEC in soil when compare to other treatments.

Soil pH

Soil pH influences the availability of nutrients to plants and it controls many biochemical reactions in soil [27]. Results (Table 7) show that from 2020-2021, soil pH decreased by 11.3% (5.82-5.23). This implies more acidity which may consequently be due to application of mineral fertilizers (NPK & Urea) and decomposition of the foliage of Jatropha [29].

Table 7: Effect of Jatropha foliage on soil pH in 2020 & 2021

| Treatment | Year 2020 | Year 2021 |
|--------------------------|-------------|-------------|
| Control | 5.77a | 5.27b |
| 5 t/ha Jatropha foliage | 5.75b | 5.17c |
| 10 t/ha Jatropha foliage | 5.94a | 5.53a |
| Full-RF | 5.80a | 4.95d |
| Mean | 5.82 | 5.23 |
| SE± | 0.08 | 0.02 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

In year 2021 (Table 7), the highest pH value (5.53) was recorded in treatments having 10 t/ha Jatropha foliage while the least pH value (4.95) was in treatments having Full-RF. Organic materials are known to regulate soil pH through enhanced buffering capacity [30], whereas, most N fertilizers are acid forming substances that cause rapid acidification of Agricultural lands [29].

Grain Yield (2020 and 2021 wet seasons)

The grain yield is important, because in poorer countries, pearl millet is principally grown for its grain [31]. From 2020 to 2021, mean grain yield (Table 8) increased by 3.4% (1684.6-1741.8 kg/ha). This may be due to carryover effect of nutrients from 2020 to 2021, especially for treatments that received *Jatropha* foliage or mineral fertilizer. The availability of nutrients from previous applications can benefit next year's crop(s) by up to 20-60%, provided the nutrients are not lost through leaching, erosion, volatilization or runoff [30].

Table 8: Effect of *Jatropha* foliage on grain yield of pearl millet in 2020 & 2021

| Treatment | Year 2020 | Year 2021 |
|---------------------------------|---------------|---------------|
| Control | 1121.7c | 1084.0c |
| 5 t/ha <i>Jatropha</i> foliage | 1385.8bc | 1445.7b |
| 10 t/ha <i>Jatropha</i> foliage | 1505.0b | 1567.3b |
| Full-RF | 2725.8a | 2870.3a |
| Mean | 1684.6 | 1741.8 |
| SE± | 164.7 | 93.8 |

Means followed by the same letter within each column are not statistically different ($p < 0.05$) using LSD

The control treatment recorded a decline in grain yield (1121.7 to 1084 kg/ha) over the same period probably due to lack of replenishment from external sources. Toure et al. [32] reported a mean grain yield of 1130 kg/ha against 813 kg/ha (control).

In both years, inorganic fertilizer was significantly superior to the other treatments in increasing the grain yield of pearl millet. In 2021 (Table 8), the control treatment significantly yielded the same grains as treatments with 5 t/ha *Jatropha* foliage probably due to lower amount of nutrients in the 5 t/ha rate of *Jatropha* foliage. However, the 10 t/ha rate of *Jatropha* foliage was significantly superior to the control treatment as a result of the higher quantity of nutrients compared to the 5 t/ha rate. In 2021 (Table 8), *Jatropha* foliage (at both 5 and 10 t/ha rates) significantly yielded higher amount of grains (33.4 to 44.6%) than the control treatment perhaps due to accumulation of more nutrients as a result of carryover effects. Generally, *Jatropha* foliage (5 or 10 t/ha rate) could not achieve the significant yield levels attained by full recommended rate (Full-RF) of mineral fertilizer even though the 10 t/ha rate of *Jatropha* foliage significantly increased grain yield by 34.2-44.6% in both years

DISCUSSION

Soils of the Nigerian Sudan savannah (dominated by Inceptisols and Entisols) are frequently low in soil fertility probably due to intensive nutrient mining and the lack of adequate replenishment from external sources. Nutrient depletion and soil degradation have been identified as major constraints to crop production in the area [33]. The natural productivity these soils widely depends on organic matter and clay content [34]. To meet the NPK requirements of crops, large application of organic resources ($>10 \text{ t ha}^{-1}$) is needed, especially if used alone on low fertility soils of Sudan Savanna [35]. Cooperband [36] noted that the building and maintenance of soil organic matter through the application of organic amendments can be achieved by sustained efforts of regular or incremental addition. Organic carbon is the most frequently used attribute in measuring soil quality/fertility [37].

Phosphorus has been described by Mason *et al.* [24] as the most important nutrient element that limits pearl millet production in West Africa. Recently, Stewart *et al.* [25] identified phosphorus deficiency to be among the top 3 factors (N, P and organic carbon) that limit soil fertility in West Africa and the top proposed remedies to include the application of mineral fertilizer (N and P) plus organic resources.

In soil fertility, Phosphorus and Potassium are regarded as problematic nutrients because of low solubility and fixation [27]. However, maximum phosphorus efficiency is achieved by keeping the soil pH within a range of 6.0 to 7.0, application of P mineral fertilizer and addition of fresh organic matter [29].

Practices that improve exchangeable K in soil include the use of conservation tillage, application of K fertilizers and addition of organic inputs. While fixation, leaching, erosion and plant removal cause losses of this essential macro nutrient [27]. However, the availability of K to plants is related to its relative concentration to Ca and Mg and not just on the total amount in soil [30]. Mg induced K deficiency was reported for Southern Ethiopian soils [26]. Moreover, Potassium is relatively much rapidly released from organic residues as it does not form part of the organic molecules [38]. In a 3-year wheat-cotton field trial, Sui *et al.* [39] concluded that the effect of inorganic K fertilizer was the same as residue incorporation.

Cation Exchange Capacity helps soils to hold more cations and prevent the loss of anions such as nitrates, sulphates and chlorides. CEC is important to soil fertility as higher CEC implies greater amounts of calcium, magnesium and potassium. Lower CEC values ($<10 \text{ cmol}_c \text{ kg}^{-1}$) are typically associated with sandy soils. Low CEC values cause soils to be highly acidic and therefore require more frequent liming and lime [40]. However, organic matter and clay contribute greatly to soil CEC [27].

Lower pH values (<5.5) are detrimental to soil organisms and can inhibit the availability of key plant nutrients such as N, P, K, S and Mo. A pH range of 5.5-7.0 is considered optimal for the production of most vegetables and grains [27]. Most fertilizers and organic materials are known to be acid forming substances, which is the main reason for the rapid acidification of farm lands [29].

Generally, there were increases in grain yield of pearl millet (2020-2021 seasons). This may be attributed to carryover effects of nutrients from one season to next year's season. It has been mentioned by Havlin *et al.* [30] that the availability of nutrients from previous application can benefit next year's crop(s) by 20-60% (provided the nutrients are not lost through erosion, leaching, volatilization and runoff). Grain yield from sole mineral fertilizer was significantly superior to those recorded by sole *Jatropha* foliage. This may be due to higher concentration of major plant nutrients (NPK) in the mineral fertilizer when compared to *Jatropha* foliage. Mineral fertilizers contain higher amount of major plant nutrients (NPK) and they cause spectacular increase in the yield of crops [29]. The great increases in global food supply from 1960s to date is much attributed to the use of mineral fertilizer, which consequently reduced the cost of crop production [41]. However, when compared to control treatment, sole *Jatropha* foliage (at the rate of 10 t ha^{-1}) was able to significantly improve the grain yield of pearl millet (both seasons). With respect to increase in grain yield of pearl millet, the general trend showed that mineral fertilizer is significantly superior to *Jatropha* foliage while *Jatropha* foliage is significantly superior to control treatment.

CONCLUSION

The effect of *Jatropha* foliage as a soil amendment was evaluated under Sudan Savannah conditions to assess the change in level of nutrients and grain yield of pearl millet from year 2020 to 2021. Organic Carbon, available Phosphorus, exchangeable Potassium, CEC and grain yield all increased. This may be due to carryover effect of nutrients (2020-2021). *Jatropha* foliage at the rate of 10 t/ha significantly increased grain yield over control treatment, while mineral fertilizer was significantly superior to *Jatropha* foliage in increasing the grain yield of pearl millet. Therefore, the application of *Jatropha* foliage at high rates ($\geq 10 \text{ t/ha}$) is recommended for the Sudan Savannah of Nigeria as it sustained and improved soil nutrients level and grain yield of pearl millet.

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