Research Journal of Agriculture and Forestry Sciences _____ISSN 2320– 6063
Vol. **9(3),** 1-4, July **(2021)** *Res. J. Agriculture and Forestry Sci.*

Proximate and mineral composition of *Corchorus olitorius* in response to combined tree legume based organic and mineral fertilizer treatments

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Availableonlineat:www.isca.in,www.isca.me
Received 1st July 2020, revised 15th April 2021, accepted 15th June 2021

Abstract

This study was conducted to investigate the quality analysis of Corchorus olitorius in response to combined tree legume-based organic and mineral fertilizer treatments. The high cost, shortage, and low efficiency of mineral fertilizer makes it unbeneficial for farmers, poor soil fertility and nutrient depletion plus continuous addition of mineral fertilizers has led to soil acidification, nutrient in-balances, and soil degradation and this forms the rationale of this study. Four treatments which include; A (application of NPK only at 200kg/ha or 20g/m^2), B (application of Leucaena leucocephala leaf meal at 400kg/ha or 40g/m^2), C (application of combined Leucaena leucocephala leaf meal + wood ash + poultry waste at 20g + 10g+10g=40g/m^2), D (Control; no fertilizer application) each with three replicates following the principle of randomization in applying the treatments were used. It was clearly revealed that the significant result was observed in plants treated with the combination of the various fertilizer types, also application of both organic and inorganic fertilizers has a positive response on the content of Corchorus olitorius plant. Since the Corchorus olitorius treated with various organic and inorganic fertilizer treatment shows a positive response on the mineral and proximate content, therefore the use of these combined fertilizer treatments should be encouraged by farmers to improve crop yield and productivity.

Keywords: Proximate, mineral, legume, organic, fertilizer treatments.

Introduction

Corchorus olitorius belongs to the Tiliaceae family and it is an annual, unbranched herb, 90 to 120 cm tall, with glabrous stems, leaves 6 to 10 cm long, and 3.5 to 5 cm broad, with pale yellow flowers and black trigonous seeds[1]. *Corchorus olitorius* is widely grown in the tropics for the viscosity of its leave[2].

In the south-western States of Nigeria, particularly Ogbomoso, *Corchorus olitorius* is one of the major leafy vegetables widely grown and utilized as pot-herb[3]. The leaves are cooked into thick viscous soup added to stews and eaten with starchy staples[4], and are rich sources of vitamins and minerals[5]. *Corchorus olitorius* are a very good source of proteins, vitamins (A, C, E) and they are also rich in mineral nutrients like calcium and iron[6,7]. It is also known to contain high levels of iron and folate which are useful for the prevention of anemia[6]. As a result of the high demand for consumption, reduction in the availability of this species is predicted coupled with the deficiency of soil nutrients.

Poor soil fertility and nutrient depletion continue to represent huge obstacles to securing needed harvest in Africa[8]. The high cost of mineral fertilizers, scarcity, and low efficiency of mineral fertilizers also makes it unprofitable for farmers, moreover, an inadequate supply of organic matter can lead to continuous use of mineral fertilizers which can result in soil acidification, nutrient in-balances and soil degradation. Also, the continuous use of mineral fertilizers alone for crop production can lead to the build-up of component inorganic residue which reduces the quality of agricultural products[9]. Furthermore, the future requires that farmers cultivate the same piece of land continuously and as a result, farmers are faced with the challenge of increasing food production on existing land that are already in cultivation[9].

Since organic fertilizer has been suggested to complement inorganic or chemical fertilizer and bridge the demand and supply for fertilizer and for economic and environmental reasons[10,11] and the use of organic and mineral fertilizers can help to improve sustainable soil productivity[12]. Therefore the rate of growth and quality yield products of *Corchorus olitorius* can be influenced by the application of both organic and inorganic fertilizers because the application of these combined green manure and mineral fertilizers (NPK) can have great effect on the growth and quality of the vegetable.

To ensure soil productivity, plants must have an adequate and balanced supply of nutrients that can be realized through integrated nutrient management where both natural and man-made sources of plant nutrients are used[13]. Therefore, this study was aimed at assessing the rate of growth and quality of *Corchorus olitorius* as influenced by the application of both organic and inorganic fertilizers with the view to increase sustainable soil productivity and yield of *Corchorus olitorus* under intensive cultivation.

Methodology

The experiment was carried out at the Teaching and Research Farm, Federal University of Technology Akure, Longitude 5.14641 and Latitude 7.29679, with a mean annual temperature of 26.7° C and rainfall of 2378m per annum.

The leaves of *Leucaena leucocephala* was collected from the agroforestry demonstration plot of the Department of Forestry and Wood Technology, Federal University of Technology, Akure. Poultry waste was collected from Animal concept poultry, Akure. Wood ash was collected from household kitchen. The conventional NPK (40g/m^2) fertilizer was purchased from the fertilizer market. The *Leucaena leucocephala* leaves were sundried and ground into leaf meals using mortar and pestle. Thereafter the tree legume-based fertilizer was compounded by mixing the leaf meal (20g/m^2) with ground poultry waste (10g/m^2) and wood ash (10g/m^2) at a ratio of 2:1:1 comprising of two portions of *Leucaena leucocephala* meal, one portion of poultry waste meal and one portion of wood ash. The design of the experiment was a Completely Randomized Design (CRD) with four treatments, each at three replicates and the treatments include; *Leucaena leucocephala* Leaf meal, NPK, a combination of *Leucaena leucocephala* leaf meal, wood ash and poultry waste (LLM+WA+PW) and Control (no fertilizer application).

The design of the experiment is; $Y_{ij} = \mu + T_i + £_{ij}$

Where: Y_{ij} is the individual observation observation, μ is the population mean, T_i is the treatment effect and $£_{ij}$ the experimental error.

Experimental procedure: A land area of 20mx20m was divided into plots of 1mx1m each separated by 0.5m buffer zone. The plots were properly loosed while all weed and debris were removed. The plots were randomly allocated to experimental treatments of NPK fertilizer (200kg/ha); Combination of *Leucaena* leaf meal, wood ash and poultry waste (LLM+WA+PW) (400kg/ha); *Leucaena leucocephala* leaf meal alone (400kg/ha) and Control (no fertilizer application).

Proximate mineral and profile analysis: Determination of Potassium (K): Potassium (K) in *Corchorus olitorius* was determined using the flame photometer. O.5ml of the sample solution was pipetted and distilled up to 10ml with distilled water.

$$\% \text{ K} = \frac{T \times V \times R \times 10^{-4}}{W}$$

Where: R = Reading of the flame photometer, W = Weight of ash sample.

Determination of Sodium (Na): Sodium (Na) in *Corchorus olitorius* was determined using the flame photometer. 0.5ml of the sample was read on the flame photometer.

$$\% \text{ Na} = \frac{T \times V \times R \times 10^{-4}}{W}$$

Where: R = Reading of the flame photometer, W = Weight of ashed sample.

Determination of Calcium (Ca): Calcium (Ca) in *Corchorus olitorius* was determined by pipetting 10ml of sample solution into 25ml conical flask (V_2), 5ml of 20% KOH was added, 10 drops of 2% potassium cyanide KCN and 10 drops of 5% hydroxyl animehydrochloride ($OH.NH_2.HCl$) was added. Also, a pinch of calcine indicator put in the solution and titrated with 0.01 M EDTA and color is expected to change at titer value T.

$$\% \text{ Ca} = \frac{T \times MEDTA}{100} \times \frac{v_1}{v_2} \times \frac{100}{w} \times 40$$

Where: T = Titre value, M = Molarity of EDTA = 0.01M, V_1 = 50ml, V_2 = 10ml, 40 = Molar mass of calcium, W = Weight of the ash.

Determination of Copper, Zinc, and Iron (Cu, Zn, Fe): Atomic absorption analysis calibration was determined by the value of copper, zinc, and iron. The stock standard of 10ppm was for each of the metal analyzed. A bulk model 2.00 A flame atomic absorption system was used. Their individual ppm was calculated using the expression below:

$$\text{ppm} = \frac{10ppm}{Standard\ reading}\ X\ sample\ reading$$

The standard reading for each element will be different from one another. Standard reading for Fe = 96.5, Zn = 96.2, Cu = 45.5.

$$\text{ppm sample} = \frac{R \times V}{W}$$

Where: R = value calculated above, V = Final volume of extract, W = Weight of the sample.

Statistical analysis of Data: The data collected was subjected to Analysis of Variance (ANOVA) at p>0.05 level of significance. Fisher's least significant difference (LSD) method was used to test for the significant differences between the treatments.

Results and discussion

Proximate content of *Corchorus olitorius* in response to fertilizer types: As shown in Table-1, *Corchorus* plant treated with the various fertilizers has an average moisture content (M.C) of 17.23% and this is in agreement with the findings of Fagbemi[14] which stated that the estimated plant had moisture content of about 15-20% which was very high when compared to moisture content of most leguminous plants which is usually between 7.0±00 and 11.0±00%.

The average crude fiber of *Corchorus olitorius* (5.82%) in response to the various fertilizers applications is similar to the report given by Onwordi and Wusu[15] and according to Ishida *et al.*[16], Rao and Newmark[17], adequate intake of dietary fiber can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer.

Corchorus olitorius plant grown with Leaf meal has the highest fiber and a moisture content, N.P.K has the highest ash content (9.86%), this is similar with the result given by Oyedeji et al.[18], also a combination of LLM+WA+PW has the highest crude protein with an average value of 25.23%, which is higher compared to the findings of Oyedeji et al.[18] but in agreement with the findings of Ayeni[19], Akanni *et al.*[20]; and Ogunlade *et al.*[21] who stated that the combinations of organic and mineral fertilizer have been reported to perform better on the yield of tomato, maize, and *Solanum macrocarpon* than when each is solely applied. Hence, organic manure is known to be capable of activating many species of microorganisms that release phytohormones that stimulate nutrient absorption and plant growth[22].

Corchorus olitorius plant grown with no fertilizer application (control) has the highest Fat and carbohydrate content of 5.54% and 44.59% which is higher compared to result of Oyedeji *et al.*[18] and this result proves that plants treated with organo-mineral fertilizer perform better than the control but not as much as NPK and poultry manure. Also from the result, the *Corchorus* plant treated with NPK, LLM+WA+PW has a high content of crude protein, K and Ca and this agrees with Steyn *et al.*[6] and Dansi *et al.*[7] which says that edible species of *Corchorus* are a very good source of proteins, vitamins (A, C, E) and they are also rich in mineral nutrients like calcium and iron. The high amount of potassium observed in the *Corchorus* plant agreed with the observation of Achinewhu[23] who reported that potassium is high in plant foods from Nigeria soil.

Mineral profile Parameters of *Corchorus olitorius* in response to fertilizer types: It was observed that the Cu content was not detected *Corchorus* plant treated with the various fertilizer types and plant grown without fertilizer application. Ca was present in all the plants treated with fertilizer types but was significantly higher in NPK and Leaf meal. The concentration of Fe was not visible because it has a very minute value compared to the other elements. The mineral content of Zn was observed in plants treated with NPK though little and was not found in other plants treated with Leaf meal and LLM+WA+PW. NPK and Leaf meal has the same value of K content expect for the one treated with LLM+WA+PW as shown in Table-2.

Conclusion

As it is clearly revealed in the results, the most significant result was observed in plant treated with the combination of the various fertilizer types, also application of both organic and inorganic fertilizer has a positive response on the content of *Corchorus olitorius* plants. Since the *Corchorus olitorius* treated with various organic and inorganic fertilizer treatment shows a positive response on the mineral and proximate content, therefore the use of these combined fertilizer treatments should be encouraged by farmers to improve crop yield and productivity.

Table-1: Proximate content parameters of *Corchorus olitorius* in response to fertilizer types.

Fertilizer Types	Moisture content	Proximate	Contents	Parameters	Fiber	Carbohydrate
		ASH	Crude Protein	Fat		
Leaf meal	19.42^{a}	9.81^{b}	15.00^{d}	5.30^{b}	7.88^{a}	42.58^{c}
NPK	17.11^{b}	9.86^{a}	19.36^{c}	5.07^{c}	4.76^{d}	43.74^{b}
LLM+WA+PW	16.95^{c}	9.50^{c}	25.13^{a}	5.09^{c}	5.21^{c}	38.13^{d}
Control (no fertilizer)	15.42^{d}	9.41^{d}	19.61^{b}	5.54^{a}	5.41^{b}	44.59^{a}

Different alphabet means there is significance difference along the column.

Table-2: Mineral profile of *C. olitorus* in response to fertilizer types.

Fertilizer Types	Ca	Fe	Zn	K	Na
Leaf meal	5.04^{b}	0.00^{b}	0.00^{b}	8.01^{a}	0.07^{b}
NPK	5.87^{a}	0.00^{a}	0.01^{a}	8.01^{a}	0.12^{a}
LLM+WA+PW	2.71^{c}	0.00^{b}	0.00^{b}	6.01^{b}	0.06^{b}

Different alphabet means there is a significant difference along the column.

The presence of some vital elements in the leaves also showed its usefulness as a good source of energy, protein, fiber and vitamins which is essential for the human body. It is therefore recommended that the use of combined fertilizers should be encourage by farmers since it is affordable and environmentally friendly. Also, the leaves of the *Corchorus olitorius* should be often consumed by human since it has been proved that it has a very good source of proteins, vitamins, fiber, carbohydrates, and minerals like calcium, iron, sodium, and potassium.

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