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EFFECTS OF LIQUID ORGANIC FERTILIZER ON GROWTH AND YIELD CHARACTERISTICS OF WATERLEAF (*Talinum triangulare* (Jacq) Willd). IN JOS, PLATEAU STATE, NIGERIA

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ABSTRACT

Organic fertilizers are valuable resources for improving soil fertility, however recent studies have shown organic matter to be a critical factor affecting soil fertility in Jos Metropolis. This study therefore investigated the effect of liquid organic fertilizer on the growth and yield characteristics of waterleaf (*Talinum triangulare*) with the aim of improving its productivity. The experimental treatment consisted of 20, 40, 60 and 80litres/ha of liquid organic fertilizer and a control. These were supplied using Agribloom liquid organic fertilizer. The treatments were laid out in a Randomized Complete Block Design and replicated three times. Growth and yield data collected included leaf count, plant height, number of branches and plant biomass. Data were analyzed using the analysis of variance. The result showed that there was a significant difference in terms of leaf count, plant height and number of branches among the treatments. Weight of fresh leaves for 0, 20, 40, 60 and 80 litres/ha of liquid organic fertilizer were 8,125, 8,750, 9,063, 8,438 and 7,188 kg/ha respectively. However, there was no significant effect of treatment on mean biomass weight. It was therefore concluded that although liquid organic fertilizer is beneficial for improving soil productivity further studies should be conducted to investigate long-term effects.

Keywords: Fertilizer, Growth, Organic, Yield and *Talinum triangulare*

Introduction

It is well known fact that application of organic fertilizers combined with or without inorganic fertilizer to soil is considered as a good management practices in any agricultural production system because it improves plant quality and soil productivity and fertility (Isah *et al*., 2018). However, organic and inorganic fertilizers supply nutrients to soil in different ways. Organic fertilizers create a healthy environment for the soil over a long period of time, while inorganic fertilizers work much more quickly, but fail to create a sustainable environment (Kapsiya *et al*., 2018).The use of organicinputs such as crop residues, manures and compost has great potential for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Kapsiya *et al*., 2018).

Waterleaf (*Talinum triangulare*),a popular home garden vegetable which belongs to the family of *Talinaceae* (Ibeawuchi *et al*.,2007) requires a great deal of nutrients, especially nitrogen for high yields. Waterleaf is eaten as a vegetable throughout the tropics including many countries in West and Central Africa; it is cultivated in Nigeria and Cameroon (Ibeawuchi *et al*.,2007).This leafy plant is considered to be a rich source of vitamins A and protein (Chibil, 1999). The leaves and stems of this plant are consumed as vegetables and used in the preparation of soups and stews. Sometimes, it could be eaten raw when it is added into salads. It could be sometimes added to okro soup to make it richer and greener (Ibeawuchi *et al.*, 2007).

The increasing demand for waterleaf due to urbanization has therefore pushed farmers into small and medium scale production of waterleaf in Plateau State. Consequently, to obtain optimum yield, organic fertilizers are being developed by farmers from farm and city waste for vegetable production. Also, organo-mineral fertilizers in which organic wastes are fortified with inorganic N or NP fertilizers are being utilized by crop farmers (Ipinmoroti *et al.*, 2003).

Liquid manure is manure in a liquid form. Generally, liquid manure is used as a convenient alternative to manure, which cannot be spread as evenly as its liquid form. Manure in both state is used as nutrient enriched fertilizer for plants (Chadza, 2011).However, the type of manure (that is liquid manure) applied on the soil for the cultivation of vegetable crops affects the growth characteristics of the crop. Aina (1979); reported that most of the West African Savannah soils which include the Jos Plateau State are low to very low in organic matter and plant nutrients especially N and P, which are the essential minerals needed by the soil for the proper growth of plant. On the other hand, low organic matter in soils affects soils physical properties negatively thereby leading to low soil productivity and consequently low crop yield (Brady and Weil, 1999).

However, there are little or no known studies to examine the effects of liquid organic fertilizer on growth and yield characteristics of waterleaf (*Talinum triangulare*) in Jos Metropolis. Consequently, the objective of this study to determine the effect of liquid manure on the growth and yield characteristics of waterleaf (*Talinum triagulare*) with a view to improve its productivity.

Materials and Methods

Study Site

The experiment was conducted at the experimental field of the Federal College of Forestry, Jos in the northern part of the Jos Plateau. The Jos Plateau is in the central part of the country. The Jos Plateau (Figure 1) lies between latitude 8 ^{o} 50^{1}N and 10^{o} 10^{1}N and longitude 8 ^{o} 22^{1}E and 9^{o} 30^{1}E (Kareem, 2007) and has a tropical continental climate (Owonubi, 2017). Also, it has an average elevation of about 1,250 metres above sea level and stands at a height of about 600 metres above the surrounding plains.

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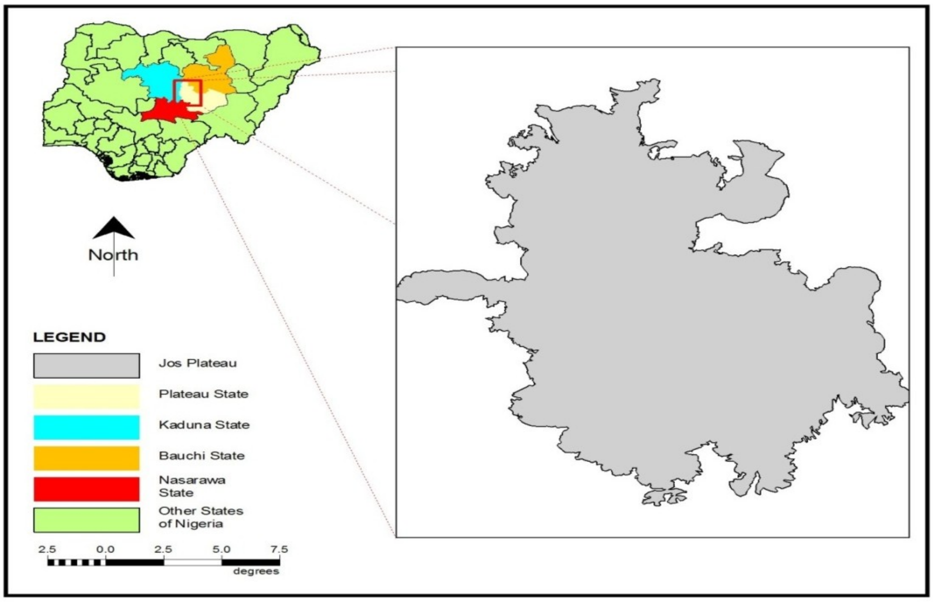

Figure 1: Location of the Jos Plateau (Source: Owonubi, 2017)

Experimental Design and Agronomic practices

The experiment was laid out in Randomized Complete Block Design (RCBD)with five (5) treatments and three (3) replicates each making a total number of fifteen (15) plots. The treatments are T1 (0litres/ha), T2 (20litres/ha), T3 (40litres/ha), T4 (60litres/ha) and T5 (80litres/ha) respectively. Soil samples were collected at random from various parts of the experimental plot at the depth of 0 – 15cm for laboratory analysis. Soil samples were analysed in the laboratory for particle size distribution, organic matter, nitrogen, available phosphorus, soil reaction, cation exchange capacity (CEC) and exchangeable cations (Ca, Mg, K, Na) using methods described by Haluschak (2006).

The land was treated with systemic herbicide in order to get rid of vegetation present on the site. The dimension for the gross plot was 13m x 8m and the experimental plot was 2m x 2m and alley way of 0.5m respectively. The beds (raised bed) of about 15 plots were constructed manually with the aid of digging hoe. The planting of waterleaf was done using stem cutting of about 15cm in lenght with a spacing of 40cm x 40cm and a total number of 25 plants were planted on each plot respectively. Weeding was carried out manually with aid of a hoe at two weeks' intervals after planting.

The agribloom liquid organic fertilizer (1ml of liquid manure per 200ml of water) was applied directly on the soil surface around the growing crop using the ring method of fertilizer application. The dose (liquid organic fertilizer) applied for each plot varied in quantity depending on the treatment. The liquid fertilizer treatment was applied in three equal split doses at two weeks' interval. Plant parameters assessed were plant height, leaf count, number of branches, collar girth, above ground biomass and weight of fresh leaves. Data collected was subjected to Analysis of Variance (ANOVA) under Randomized Complete Block Design, to test the effects of the treatments on growth and yield of waterleaf (*Talinum triangulare*)

Results and Discussion

Environmental Characteristics of the Study Area

Soil composition of experimental site

The results in (Table 1) revealed that organic matter content of the study site is 2.49% which is medium (2-3 %) according to Enwezor *et al.* (1989) rating for organic matter. Organic matter contributes to plant growth through it effect on the physical, chemical and biological properties in the soil. It serves as a nutrient reservoir for plant or a store house for plant nutrients and improves the soil properties, bulk density, soil structure and texture, cation exchange capacity (CEC) as well as infiltration capacity (Enwezor *et al.*, 1989).

Furthermore, based on particle size distribution of the soil(Table 1), the soil texture is Sandy Loam with proportion of clay, silt and sand being 9.08%, 13.1% and 78.04% respectively. According to Enwezor *et al.*, (1989), classification of soil Nitrogen, the percentage of soil Nitrogen (N) is 0.068% which is low as it is less than 0.15%. Nitrogen is the primary macro nutrient for plant growth and development.

Table 1: Soil Composition of Experimental Site

Texture	Sand*	Silt*	Clay*	OM*	N*	P^a	Ca^b	Mg^b	K^b	CEC^b	pH
Sandy Loam	78.04	13.10	9.08	2.49	0.07	2.10	4.01	0.89	0.66	1.67	6.49

Note: OM = organic matter, *: units in %; ^{a}: units in mg/kg; ^{b}: units in cmol/kg

Weather Data of the Study Site

The weather data of the period of study is shown in (Table 2) below. Minimum and maximum temperature (°C) of the study site were 20 and 27, 20 and 28.7, and 19.0 and 32.0 for the month of August, September and October respectively which is suitable for growing waterleaf. However, temperature above 35°C is not suitable for growing waterleaf according to (Chibili, 1999). Evaporation (mm) of the study site was 1.5, 1.7 and 3.0 for the month of August, September and October respectively. Rainfall (mm) of the study site was 209.7, 188.5 and 0.0 for the month of August, September and October respectively. Relative Humidity (%) for the study site was 76, 72.3 and 51.8 for the month of August, September and October respectively. This indicates a decrease in precipitation and humidity during the period of study. However solar radiation increased during the study duration, Consequently, solar radiation (kilojoules) for the study site was 168, 176 and 220 for the month of August, September and October respectively whereas, sunshine hours (Min) for the study site was 4.0, 5.6 and 8.0 for the month of August, September and October respectively. According to Chibili, (1999), Waterleaf grows best under humid conditions at temperatures of about 30^{0}C. Growth is very fast during the rainy season but will slow down considerably during the dry season. It grows well under shade and in cloudy weather. It can grow in fully exposed localities, but in this case, plants remain smaller. Growth is most profuse when the water content of the soil is close to field capacity.

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Table 2: Weather characteristics during period of Study

Months	Minimum Temperature	Maximum Temperature	Evaporation	Rainfall	Relative Humidity	Solar Radiation	Sunshine hours
	^{0}C		mm		%	Kilojoule	
August	20	27	1.5	209.7	76.0	168	4.0
September	20	28.7	1.7	188.5	72.3	176	5.6
October	19	32	3.0	0.0	51.8	220	8.0

Source: Meteorological Station, University of Jos. (2021)

Plant Growth Parameters

Leaf count and plant height

Plant growth data during the period of growth is presented in Table 3to9. There was significant effect (P < 0.05) on leaf count when subjected to different quantities of liquid organic fertilizer from week 3 to week 7 with treatment 2 having the highest mean at 7 weeks (79.3), followed by treatments 1, 3, 4 and5 respectively. On the other hand, there was significant effect (P<0.05) in plant height when subjected to different quantities of liquid organic fertilizer from week 3 to week 7 with treatment 3 having the highest mean (26.9cm) followed by treatments 1, 2, 4 and 5. This indicates that treatment 3 had the best effect on the plant height of waterleaf (*Talinum triangulre*).

Number of branches and collar girth

Mean collar girth for 0, 20, 40, 60 and 80 litres/ha of liquid organic fertilizer were 2.4, 2.8, 2.4, 2.6 and 2.8 cm respectively. However, there was no significant effect (P>0.05) of the treatment on collar girth. There was significant effect (P<0.05) in number of branches when subjected to different quantities of liquid organic fertilizer at 12 after transplanting with treatment 5 having the highest mean (7.7) followed by treatments 1, 2, 3 and 4. This indicates that treatment 5 had the best effect on the number of branches of waterleaf (*Talinum triangulare*).

Table 3: Analysis of Variance of *T. triangulare* for Leaf count within 7 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	1977.60	1977.60	28.97	0.000
Treatment	4	627.70	156.92	4.60	0.032
Error	8	273.04	34.13		
Total	14	2878.34			

Table 4: Analysis of Variance of *T. triangulare* for plant height within 7 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	26.086	13.043	4.54	0.048
Treatment	4	40.160	10.040	3.50	0.062
Error	8	22.975	2.872		
Total	14	89.221			

Table 5: Analysis of Variance of *T. triangulare* for number of branches within 12 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	1.0613	0.5307	1.05	0.395
Treatment	4	19.0933	4.7733	9.41	0.004
Error	8	4.0587	0.5073		
Total	14	24.2133			

Table 6: Analysis of Variance of *T. triangulare* for collar girth within 12 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	0.01641	0.00821	0.14	0.875
Treatment	4	0.48123	0.12031	1.99	0.189
Error	8	0.48325	0.06041		
Total	14	0.98089			

Table 7: Analysis of Variance of *T. triangulare*for biomass within 12 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	634.25	317.13	3.17	0.097
Treatment	4	328.66	82.17	0.82	0.546
Error	8	799.13	99.89		
Total	14	1762.05			

Table 8: Analysis of Variance of *T. triangulare* for weight of fresh leaves within 12 weeks of study

Source	Degree of freedom	Sum of squares	Mean square	F	P
Replication	2	216.23	108.12	5.58	0.030
Treatment	4	60.66	15.16	0.78	0.567
Error	8	155.14	19.39		
Total	14	432.03			

Table 9: Average Growth Data

Treatment	Leaf count*	No. of Branches#	Plant Height*	Collar Girth#	Biomass#	Wt of Fresh Leaves#
Litres/ha			Cm			kg/ha
0	67.4^{ab}	5.6^{c}	22.0^{b}	2.4^{a}	23,750	$8,125^{A}$
20	79.3^{a}	6.0^{bc}	25.3^{ab}	2.8^{a}	26,478	$8,750^{A}$
40	59.8^{b}	6.7^{abc}	26.9^{a}	2.4^{a}	23,936	$9,063^{A}$
60	73.1^{ab}	8.7^{a}	25.0^{ab}	2.6^{a}	26,478	$8,438^{A}$
80	68.5^{ab}	7.7^{ab}	25.7^{ab}	2.8^{a}	22,572	$7,188^{A}$

Note: *:at seven weeks of growth; #: at 12 weeks of growth, mean that do not share a letter are significantly different

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Total biomass and weight of fresh leaves

Mean biomass for 0, 20, 40, 60 and 80 litres/ha of liquid organic fertilizer were 23,750, 26,478, 23,936, 26,478 and 22,572 kg/ha respectively. Mean weight of fresh leaves for the set of treatments were 8,125, 8,750, 9,063, 8,438 and 7,188 kg/ha respectively. However, there was no significant effect (P>0.05) of the treatment on biomass and weight of fresh leaves.

Discussion

Leaf count values were higher than that reported by Ndaeyo *et al.,* (2013) who documented a leaf count of 10.1 to 13.3; but almost at par for number of branches (6.4 - 21.3) and a plant height ((8.8 to 10.9 cm) when using 5tha^{-1} of poultry manure. Furthermore, though there were no significant effect of treatments on plant biomass, values obtained were lower than that recorded by Ndaeyo *et al.,* (2013). Liquid organic fertilizers have low concentration of nutrients especially when compared to conventional inorganic fertilizers (Brady and Weil, 1999; Cabilovski *et al,* 2014). Nitrogen is required for robust vegetative growth of vegetables. The low levels of biomass production and the resultant non-significant effect of the treatments could be a consequence of the inherently low level of nitrogen both in soil and in the liquid organic fertilizer.

Furthermore, Brady and Weil (1999) had noted that when nitrogen in soil is in short supply, the amount in soil could be immobilized by soil micro-organisms making it unavailable for plant growth especially for plant with short growing periods as water leaf. Likewise, Jigme *et al,* (2015) noted that *Brassica oleracea* plants produced higher vegetative growth when treated with inorganic fertilizers than with organic fertilizers. This was attributed to higher concentrations of nutrients in the inorganic fertilizers. Furthermore, Purbajanti and Setyowati (2020) reported that the interaction between soilid and liquid organic fertilizers significantly affected the yield of pakchoy (a Chinese leafy vegetable). It is probable that the source from which the liquid organic fertilizer is produced influences its performance. For example, Ji *et al* (2017) observed that the liquid organic fertilizers significantly promoted root and aboveground growth by 10.2–77.8% and 10.7–33.3%, respectively, compared with inorganic fertilizer. The order of growth promotion was: L1 (shrimp extracts) > L2 (plant decomposition) > L4 (seaweed extracts)/L5 (fish extracts) > L3 (vermicompost). It was further noted that morphological and chemical analyses indicated that, compared with other organic fertilizers, the treatment with shrimp extract (L1) produced the greatest increases in root dry weight, total length, surface area, volume, tips, and thick root length, respectively. Furthermore, the shrimp extract treatment significantly increased the nutrient contents and altered the soil's functional microbial community at the rhizospheric level compared with the chemical fertilizer treatment. In a similar study, Martinez-Alcantara *et al*. (2016) reported that plants fertilized with animal-based liquid fertilizers exhibited higher total biomass with a more profuse development of leaves and fibrous roots. Furthermore, it was noted the liquid organic fertilization resulted in increased: uptake of nutrients compared to inorganic fertilizers, and carbohydrate content in leaves. Some studies have indicated that response to liquid organic fertilization may be dependent on the type of plant. Nhu *et al* (2018) was able to show insignificant to significant response to liquid organic fertilization when compared with inorganic fertilizers for various types of plants. Consequently, the combined used of organic and inorganic fertilizers is being advocated to improve soil productivity and fertility. This was underscored by Chen (2006) who noted that the nature and the characteristics of nutrient release of chemical, organic and biofertilizers are different, and each type of fertilizer has its advantages and disadvantages with regard to crop growth and soil fertility… therefore, a balanced fertilization strategy that combines the use of chemical, organic or biofertilizers must be developed and evaluated.

Conclusions

The outcome of this present study has further underscored the importance of liquid organic fertilizers for improvement in soil productivity. However, there were no significant effects of treatments on biomass of water leaf probably as a result low levels of soil nitrogen. It is recommended that future studies should consider the effects of complimentary applications of inorganic fertilizers to supply either nitrogen, phosphorus and or potassium on growth and yield of water leaf.

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