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EVALUATION OF *TITHONIA DIVERSIFOLIA* FOR SOIL IMPROVEMENT IN CELOSIA (*CELOSIA ARGENTEA*) PRODUCTION.

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ABSTRACT

Field experiments were conducted between June and September in the 2007 and 2008 cropping seasons at the teaching and experimental field of the National Horticultural Research Institute ($7^0$25"N and $3^0$52"E), Ibadan, Oyo State, Nigeria. To evaluate the growth and yield of *Celosia argentea* L. using different rates of Tithonia diversifolia and also to evaluate the effect of the amendments on soil chemical properties. The experimental design was a Randomized Complete Block Design (RCBD) with three replicates with plot size of $4m^2$. *Tithonia diversifolia* was chopped, (fresh leaves and young stem) applied at 0, 2.5, 5, 7.5, 10 and 20 tons ha^{-1} on fresh weight basis. These were incorporated into the soil two weeks before planting. Results indicated that soil P, Ca, CEC, K and soil organic matter content were significantly ($P < 0.05$) improved by the addition of *Tithonia.* There were significant treatment effect on soil pH, N, P, K, Mg and Zn ($P < 0.05$) which were improved with the use of *Tithonia*. Growth parameters: number of leaves, plant height and stem girth increased significantly ($P< 0.05$) with the application of *Tithonia diversifolia.*

KEYWORDS

Amendment, tithonia diversifolia, celosia argentea.

INTRODUCTION

The low nutrient status of most tropical soils necessitates the use of fertilizers for intensive cultivation (Adetunji, 1991), since they are not able to support sustainable crop production over a long time (Adeoye *et al.,* 2005). As land is continuously cultivated for food production, often with poor management practices, the soils in many areas become less fertile with a reduction in important plant nutrients and ultimately, in quality.

Soil qualities known to directly and indirectly affect the nutritional quality of crops includes pH, available nutrients, texture, organic matter content and soil water relationship (Hornick, 1992). Out of these, soil organic matter plays a major role and also directly affects the others. In most agricultural soils, organic matter is increased by leaving residue on the soil surface, rotating crops with pasture or perennials, incorporating cover crops into the cropping rotation, or by adding organic residues (Krull *et al*, 2004). Organic sources of fertilizer are often proposed as alternative to commercial mineral fertilizers. These organic materials including crop residues, animal manure, sewage sludge and composted organic matter have been reported to favour high yield and quality of food crops (Asuegbu and Uzo, 1984).

Tithonia diversifolia is an invasive, annual weed, growing aggressively along road path, abandoned farmlands and hedges all over Nigeria. It has been used successfully to improve soil fertility and crop yields in Kenya (Jama *et al*., 2000), Malawi (Ganunga *et al*., 1998), Rwanda (Drechsel and Reck, 1998) and Zimbabwe (Jiri and Waddington, 1998). It is also being recently used in Nigeria. It has different uses, including use as ornamental plant, animal feed (Farinu *et al*., 1999; Olayemi, 2006) insecticide (Akanbi *et al*., 2007), nematicide and soil fertility improvement (Jama *et al*, 2000). Other uses of tithonia includes; mulching, fodder, fencing and as local herbs.

The use of Tithonia as an effective source of biomass for annual crops has been reported for rice (Nagaraj and Nisar, 1982) and it has been more recently reported as a nutrient source for Okro (Olabode et al., 2007) and maize in Nigeria. The advantage of using this particular weed for soil improvement includes its relative abundance, adaptability and its ability to grow on abandoned/waste lands along major roads and environment coupled with its rapid growth rate on waterways and on cultivated farmlands, with high vegetative matter turn over and low lignin content. Fresh organic residues, especially green manure crops, like tithonia, contain a wide variety of compounds. These vary from water soluble substances (such as sugars, amino acids, and some starches) to less soluble materials (such as pectins, proteins, and more complex starches) to insoluble celluloses and lignin.

In addition, there are varying amounts of fats, oils, waxes, and extractives such as resins and terpenes. Most of the water-soluble substances are immediately available to microbes and are metabolized quickly unless they are physically inaccessible because of location within large fragments. The pectins, proteins, and starches also are readily metabolized.

The hemicelluloses, alpha celluloses, and lignins are increasingly difficult to decompose. Although fats, waxes, oils, resins, and terpenes were once thought to be quite resistant to decomposition, it is now known that most of them are readily metabolized by specific microbes (Broadbent 1948).

Celosia (*Celosia argentea* L.) is grown across Africa and beyond as a vegetable for family consumption, market and medicinal purposes because of its prolific leaf production, nutritive and regenerative ability when cut, and its drought tolerance compared with other indigenous vegetables (Ojo and Kintomo, 2001). The leaves and stem are consumed as vegetables because it constitutes a cheap and rich nutrient source for the low income earners; the seeds could be processed into food items, supplements and additives. Typically low in calories, low in fat, high in protein per calorie, high in dietary fiber, high in iron and calcium, and very high in phytochemicals such as vitamin C, carotenoids, lutein and folic acid.

This study was therefore carried out to investigate the potentials of *Tithonia diversifolia* in soil fertility improvement for improved celosia performance in Ibadan, southwestern, Nigeria and to evaluate the effect of tithonia on soil chemical properties.

MATERIALS AND METHODS

TRIAL SITE

The field experiments were conducted at the experimental field of the National Horticultural Research Institute, Ibadan ($7^0$25"N and $3^0$52"E) during August 2007 and June 2008 cropping seasons.

ROUTINE SOIL ANALYSIS

Topsoil samples at a depth of 0–15 cm were collected at different points on the experimental field before planting. The samples were bulked, air-dried and screened through a 2 mm sieve. The soil pH (H_20) was determined with the glass electrode using a 1:1 soil to water ratio (McLean, 1982). Particle-size distribution was determined by the hydrometer method (Bouyoucous, 1965). For the exchangeable bases determination (Mg, Ca, Na, K), the soil samples were extracted in 1 M neutral ammonium acetate (NH_4OAC). The Na and K were determined using the flame photometer (CORNING 40 Model) while the Ca and Mg were determined using the atomic absorption spectrophotometer (Model 210 VGP). The exchangeable acidity (H and Al) were determined by the Walkley and Black wet dichromate method (Nelson and Sommers, 1982), using a spectrometer at 600 nm (PHOTOMEC Model) for its determination. The effective cation exchange capacity was determined by the summation of the acidity and basic cations (Rhoades, 1982). The total nitrogen was determined by the Kjeldahl method; organic carbon by the Walkley and Black method, soil available phosphorus was determined by extracting in 0.03 M ammonium fluoride and 0.025 M HCl (Bray and Kurtz, 1945). The phosphorus in extract was determined using a spectrophotometer at 470 nm (PHOTOMEC Model). Proximate analysis of the Tithonia leaves for nutrient content was also carried out by standard procedure (IITA 1979).

Tithonia diversifolia (fresh leaves and soft stems) was chopped and used as green manure at rates: 0 (control), 2.5, 5, 7.5, 10 and 20 tons ha^{-1}. The experiment was laid out in a randomized complete block design with three replicates. Tithonia was incorporated into the soil two weeks before planting. Celosia seeds, TLV8 were mixed with dry fine sand (2mm) and drilled at 50cm spacing on plot size of $4m^2$ at a plant population of 33,333 plants ha^{-1}

DATA COLLECTION AND ANALYSIS

Growth parameters assessed from five weeks after planting include: Plant height, stem girth, number of leaves and fresh shoot weight. Yield data (fresh weight of young stem and leaves) was taken from seven weeks after planting, with three subsequent harvests done fortnightly. Data collected were analysed by SAS 2000 and means were compared by DMRT ($P \leq 0.05$). Post planting soil sample analysis was carried out after harvesting. Plant samples were randomly selected for tissue nutrient concentrations after the first harvest. Post planting soil and plant sample analyses were carried out at Rotas Soil Laboratory, Ibadan.

RESULTS AND DISCUSSION

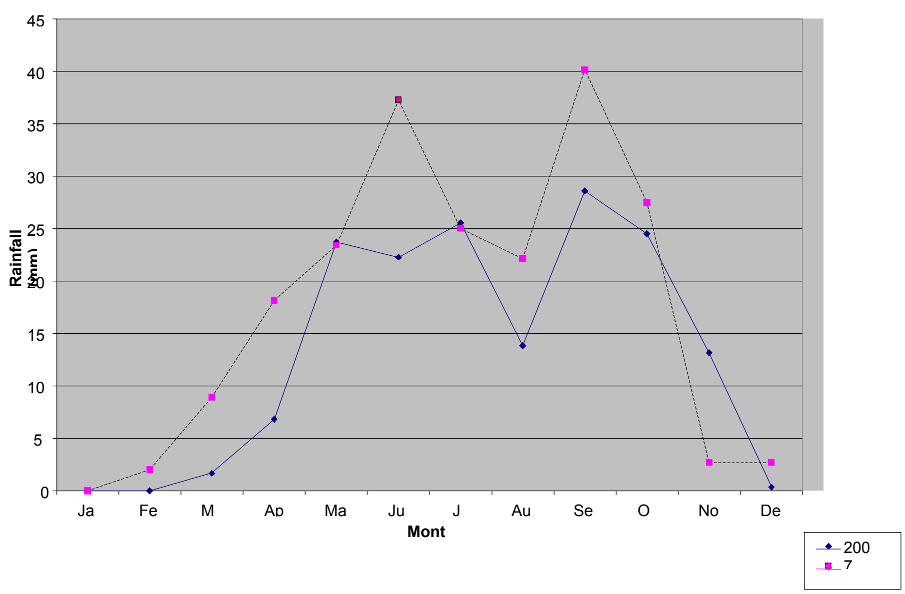
The physicochemical properties of the soils used for the experiments are presented in Table 1.

Table 1: Pre-planting physico- chemical properties of soils of the experimental site.

Soil property	pH	O.C	N	Ca	Mg	Na	K	Exch acidity	ECEC	Av.P	Cu	Zn	Fe	Mn	Textural Class
		%		C mol kg $^{-1}$						mg kg $^{-1}$					
2007	5.8	0.98	0.07	2.95	0.89	0.46	0.35	0.08	4.73	1.10	0.39	1.31	7.55	39.9	Sandy loam
2008	6.2	1.11	0.08	1.80	0.74	0.35	0.21	0.06	3.16	1.95	0.34	1.18	6.15	45.45	

The fertility status of the soil used for the study is very low in major nutrient elements (Aduayi *et al* 2002). The soil is sandy loam, low in organic carbon, nitrogen and phosphorus. This implies that cropping the soil without fertilizer use will not be economical. Average rainfall and average monthly maximum temperature of the experimental site is presented in Fig. 1.

Fig. 1: Rainfall pattern for 2007 and 2008 at Ibadan, Southwest Nigeria.



The zone where experiment was carried out is in the rain forest zone where Celosia can be grown more than twice a year because of its bimodal rainfall pattern, with proper soil management. These values were suitable for optimal growth and development of Celosia. The *Tithonia diversifolia* used had varying content of essential nutrient element and the result of its analysis is presented in Table 2.

Table 2: Proximate analysis of Tithonia used for the experiment.

Proximate	Total N	P	K	Ca	Mg	Mn	Cu	Zn	Fe	Na
Analysis	------------------------------------	-------%	--							
Tithonia	1.59	0.09	0.07	0.11	0.004	0.002	0.003	0.044	0.27	0.15

Nitrogen content of tithonia is quite high compared to other amendments, which makes it a suitable candidate as organic fertilizer. This is evident in the growth response obtained in this trial where tithonia applied plots performed better than the untreated plots as shown in Table 3 for number of leaves, plant height and stem girth.

Table 3: Growth response of *Celosia argentea* L. to different rates of *Tithonia diversifolia* amendments (mean values).

Treatment	**Number of leaves**		**Plant Height (cm)**		**Stem Girth (cm)**		**Yield (tons ha^{-1})**	
(tons ha^{-1})	2007	2008	2007	2008	2007	2008	2007	2008
0	16.16c	17.16b	25.29b	25.71c		2.76c	2.43c	4.17d
		16.40a						
2.5	18.47b	20.85ab		31.75a	34.94b	3.10c	3.21bc	5.20c
		19.70a						
5.0	19.95ab	22.86ab		32.40a	35.70b	3.17bc	3.53b	7.70c
		20.82a						
7.5	23.07a	23.62a	34.65a	36.75b	3.58ab	4.22a	8.32c	21.47a
10	25.03a	24.52a	37.32a	37.81b	3.97a	4.02a	10.42b	21.55a
20	24.59a	25.70a	38.92a	46.92a		4.00a	4.02a	15.42a
		21.60a						

Means with the same letters are not significantly different at $p<0.05$

The response for these was however higher in 2008 than in 2007. Tithonia application at 20 tons ha^{-1} produced a significantly higher number of leaves, plant height and stem girth than the other treatments. This results confirm the potential for enhanced nutrient contributions of *T. diversifolia* to production of higher leaf biomass and vigour of vegetable *C. argentea*. This is consistent with results obtained by some workers using poultry manure (Aliyu, 2002). Yield of *Celosia argentea* was also improved with the use of tithonia as a soil amendment. Yield in 2008 was however higher than the yield of celosia obtained in 2007. This could be due to higher rainfall observed for 2008.

The effect of tithonia amendments on soil properties is presented in Table 4.

Table 4: Effect of different rates of *Tithonia diversifolia* amendments on soil properties (mean values).

Treatment (tons ha^{-1})	pH	OM	N	P	K	Ca	CEC	Zn	Mg	Na
0	6.55b	1.14e	0.09b	4.60c	0.16c	0.83d	2.16d	6.66c	0.74e	0.26a
2.5	6.65ab	1.27d	0.09b	5.42b	0.25b	0.85d	2.32c	6.82bc	0.78d	0.30a
5.0	6.75ab	1.28cd	0.09b	5.49b	0.09c	0.91c	2.34c	6.80bc	0.82bc	0.26a
7.5	6.90ab	1.33bc	0.09b	5.85ab	0.27b	0.92bc	2.36c	7.43ab	0.81cd	0.25a
10	6.80ab	1.37b	0.10b	6.15a	0.25b	0.94b	2.50b	7.12ab	0.84b	0.31a
20	7.60a	1.45a	0.13a	6.30a	0.41a	0.98a	2.65a	7.55a	0.89a	0.29a

Means with the same letters are not significantly different at $p<0.05$

The pH was near neutral with the application of tithonia up to 10 tons ha^{-1}, but became higher at 20 tons ha^{-1}. Organic matter, N, P and K were also significantly improved with the applicaton of *Tithonia diversifolia* compared with the control. This trend is the same for other soil properties observed in this study like Ca, cation exchange capacity, zinc and magnesium. These properties were significantly ($P<0.05$) improved with the application of tithonia. Table 5 presents the effect of tithonia on Celosia tissue concentration.

Table 5: Effect of different rates of *Tithonia diversifolia* on Celosia tissue nutrient concentrations (%) (Mean values).

Treatments (tons ha^{-1})	N	P	K	Ca	Zn	Mg	Na
0	0.60d	0.28c	4.15b	0.86b	109b	0.79a	0.24a
2.5	0.70cd	0.29c	4.20b	0.87b	114ab	0.76a	0.42a
5.0	0.79bc	0.41a	3.57c	0.93b	114ab	0.78a	0.42a
7.5	0.83ab	0.43a	5.31ab	0.95b	115ab	0.84a	0.36a
10	0.85ab	0.40a	3.24ab	0.98b	116ab	0.80a	0.41a
20	0.96a	0.32b	6.08a	1.20a	119a	0.89a	0.23a

Means with the same letters are not significantly different at $p<0.05$

Nitrogen, P, K, Ca, and Zn were significantly ($P<0.05$) increased with the application of tithonia, while Mg and Na were not significantly affected.

Results obtained in this study are similar to results obtained by Ademiluyi and Omotosho, 2007, who obtained higher increase in yield of maize by using tithonia. The yield increase suggests the ability of *T. diversifolia* to supply needed nutrients to enhance growth and consequently increase yield, thereby improving the nutrition of Nigerians.

This results show that *Tithonia diversifolia* can be used successfully as a soil amendment to increase yield as well as improve soil properties for sustainable crop production.

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