PERFORMANCE OF CELOSIA (Celosia argentea) AS AFFECTED BY PROPORTIONATE INCLUSIONS OF TITHONIA COMPOST AND GRANULATED NPK 15-15-15 FERTILIZER IN OGBOMOSO, OYO STATE, NIGERIA

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ABSTRACT

Imbalance soil nutrition / low soil fertility is a major hindrance to attainment of sustainable crop production under tropical soil conditions, where top soil is mostly missing. However, both the organic and inorganic fertilizer materials commonly used to correct the nutrients imbalance and boost soil nutrition had been reported to be ill-famed for certain notable demerits, which may make any one of them imperfect when solely applied. Hence, the need for more researches into careful integration of two or more fertilizer materials in suitable proportions that will reasonably supply adequate nutrients for optimum performance of a common and versatile vegetable like *Celosia argentea* in the study area. Field experiment was conducted during the crop season in the year 2022, at the Teaching and Research Farms, Ladoke Akintola University of Technology, Ogbomoso, Nigeria, to evaluate *Celosia argentea* under different proportionate integrations of tithonia compost and NPK 15-15-15 fertilizer, at recommended rates of 6 tons ha^{-1} and 300 kg NPK ha^{-1} respectively. The treatments investigated were: T0 = the control, which received none of the fertilizers, T1 = 100% NPK (@300kgNPKha^{-1}), T2 = 100% Tithonia compost (@6tonsha^{-1}), T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost, and T5 = 25% NPK + 75% Tithonia compost. The trial was laid out in a Randomized Complete Block Design (RCBD), replicated thrice. Data collected were on growth and yield parameters, which were analyzed using ANOVA at $p < 0.05$. *Celosia argentea* responded well to improved soil nutrition via fertilizer application at varying levels of inclusion of both tithonia compost and NPK fertilizer, as enhanced growth and yield parameters were observed in plants which received any of the fertilizer treatments tested, comparable to the control which received no fertilizer application, in the study area. Tithonia compost is a dependable potential fertilizer material, as its applications (irrespective of the levels of inclusion with the NPK), significantly improved all the growth and yield parameters as well as the nutrient uptakes of *Celosia argentea.* Application of 100% tithonia compost effectively and successfully competed with application of NPK fertilizer at 100% recommended rate. Therefore, any of the tithonia compost inclusions ranging from 50% to 100% (depending on the availability) is therefore suggested to be applied to soils by local farmers. This will definitely reduce or completely eradicate chemical loads on soils, which will eventually favour improvement of soil quality, soil productivity, as well as production of hygienically saved farm produce in the study area.

Key words: *Indigenous celosia variety, compost, Tithonia diversifolia, NPK fertilizer, soil properties*

INTRODUCTION

Celosia argentea is an edible leaf vegetable which is typically erect, short-lived annual herbaceous edible plant. It grows up to 150 cm in height and also referred to as cocks' comb or Lagos spinach. Celosia belongs to the genus Celosia of the pigweed family 'Amaranthaceae'. It is also called Quail grass, Sokoyokoto by the Yoruba's ethnic group in Nigeria (Babatola and Etukudo, 2013). Its centre of origin is believed to be India but, it is widely cultivated in the tropical regions of Africa (West Africa inclusive). Celosia plant is well known for its high dietary, culinary and medicinal values. Celosia is an important leaf vegetable of southwestern Nigeria, which is well known for its succulent leaves rich in proteins, vitamins and minerals (Babajide and Olla, 2014). Its leaves (which are slightly mucilaginous) and young shoots are useful in soup and stew preparations. Boiled shoots are served with carbohydrate foods such as yam or yam flour, rice etc. Its uses beyond dietary and extend to medicinal purposes and treatment of ailments such as abscesses, cough, diabetes, diarrhea, dysentery, eczema, eye problems, gonorrhea, infected sores, liver ailments, menstruation problems, muscle troubles, skin eruptions, snakebites and wounds (Schippers, 2000; Aliyu *et al*., 2016). Its compatibility with other arable crops when mix-cropped or inter-cropped under traditional farming systems of the tropics, is highly fascinating, particularly under improved soil nutrition, as seen in many home gardens and segmented small patches of land (Akinfasoye *et al*., 2008; Akanbi *et al*., 2009). Despite the versatility of celosia, its performance is always limiting by soil fertility.

Rapid and continuous reduction in the tropical soil fertility status and the general soil productivity has become a great concern, and indeed a considerable set back or hindrance to the attainment of sustainable crop production or realization of food sufficiency in the tropics (Akanbi, 2002; Babajide, 2010). Noticeably, urbanization as well as the reduction in the cultivable farmland area has also become ever decreasing, leading to continuous crop cultivation or land usage intensification on the same piece of agricultural farmland (Babajide, 2014; Aliyu *et al*., 2016). As a result of these undesirable soil conditions, farmers had reportedly opted for continuously abusive application of the quick action synthetic / chemical fertilizers. Hence, the manifestation of the ill-effects (such as soil acidity, nutrient imbalances, inhibited microbial activities, nitrate pollution, health threats etc.) of abusive fertilizer applications by local farmers is now well established (Babajide, 2014; Babajide *et al.*, 2022).

Many common weeds are currently underutilized, particularly as dependable organic manure, for improving the soil fertility. One of the reasons for the underutilization is not unconnected to low level of awareness about their relatively high nutrient concentrations, which make them easily exploitable and potentially dependable organic fertilizers. Amongst such category of wild plants / weeds is *Tithonia diversifolia (Hemsl.)* A. Gray., which is simply known as Wild flower or Mexican sunflower. It is a common annual shrubby weed, belonging to the family Asteraceae. Although it is commonly found growing on waste lands, abandoned or fallowing lands, beside highways, waterways and cultivated farmlands, Mexican sunflower is adaptable to most soils and well known to extensively and aggressively grow to a considerable height of 2.5 cm or beyond (Consolacion *et al.,* 2006; Chukwuka and Omotayo*,* 2009). Little is known about its relatively high nutrient concentrations i.e. the attributed potentials of Tithonia biomass as dependable nutrient source, which a farmer can conveniently utilize for effective and economic management of his / her farmland, for enhancement of crop yields and soil quality / productivity / improvement (Jama *et al.,* 2000).

However, in order to reduce excessive chemical loads and create eco-friendliness in the course of improving soil fertility, utilization of organic fertilizers (which are equally less harmful and renewable in nature) becomes necessary either as a sole or supplementary organic fertilizer (Babajide *et al.* 2014). Since the two major classes of fertilizer (organic and inorganic) had been reported to have certain defective attributes, hence, the birth of a more environment-friendly approach (i.e. organo-mineral), which combines both the organic and inorganic fertilizer materials at desirable proportions that could supply adequate nutrients, for improving arable crop performance and tropical soil quality / properties (Babajide *et al.*, 2022). Therefore, this research was conducted to evaluate the growth, yield and nutrient uptakes of *Celosia aregentea,* under the proportionately combined NPK 15-15-15 and composted Tithonia biomass in Ogbomoso.

MATERIALS AND METHODS

Description of Experimental site

Field studies were carried out in the cropping season of the year 2023, at the Teaching and Research Farms, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, to evaluate the response of *Celosia argentea* to combined application of NPK 15-15-15 and composted *Tithonia diversifolia* biomass. Ogbomoso lies on latitude (8^0N, 10^0S) and longitude (4^0N, 10^0E) and falls under the southern Guinea Savanna Zone of the south-western Nigeria. It is characterized by bimodal rainfall distribution, with two peaks usually between 1150 mm and 1250 mm in late July / early August and October / November of each year. The maximum Temperature is 28^{0}C and the relative humidity is usually high and may be up to about 74% (Babajide *et al*., 2012).

Land clearing and preparation

Land clearing and preparation were carried out manually following farmer's conventional practice using hoe, cutlass, mattocks, rake etc. The land was manually cleared of all existing vegetations. Clearing and stumping were carried out to remove all the plant debris. The area was fenced with the use of wooden poles and wire mesh, in order to keep the site away from pests, animals and possible human disturbances.

Soil sampling and analysis

Pre-planting collection of soil sample was carried out using soil auger placed at a depth of 0-30cm, for laboratory analysis of the soil physical and chemical properties. Soil samples collected were bulked into a single composite sample. The sample was air dried, crushed and sieved through 2mm and 0.5mm mesh for the determination of the particles size, pH (H_2O), total nitrogen (N), organic carbon, available phosphorus (p), iron (Fe), copper (Cu), zinc (Zn), the Exchangeable Cations (Ca, Na, Mg and K). The particles size analysis was co nducted in accordance with the procedures of Bo uyoucos (1951) hydrometer method, using sodiu m hexamataphosphate as the dispersant. The soil was an Alfisol belonging to Egbeda (Smyth and Montgomery, 1962; Bridges, 1997).

Sowing, fertilizer application and maintenance of Celosia argentea

Celosia argentea seeds of variety Ogbomoso-Local were surface sterilized by using 95% ethanol for 10 seconds and later rinsed six times with sterile water after shaking for three to five minutes in 3% hydrogen peroxide (H_2O_2). Each Plot size was 2.0 by 2.0 m^2 i.e. 4.0m^2. Application of tithonia compost was done by incorporating the corresponding proportions of the composted materials into the soils two weeks before sowing, while NPK 15-15-15 was applied according to the predetermined proportions of the fertilizer materials at two weeks after sowing. Four seeds per hole or stand were sown at a spacing of 30 cm by 25 cm. The successfully emerged seedlings were carefully thinned to one per hole or stand, at exactly two weeks after sowing (WAS). Regular watering was maintained as at when due. Plots were manually weeded by hoeing on every fortnight basis.

Preparation of compost

Preparation of compost was done using fresh green tithonia biomass and cured poultry manure (Babajide, 2010). The fresh tithonia plants used were obtained from a nearby fallow field adjacent to the Agricultural Extension Lecture Hall located along the Teaching and Research Farms, at the teaching and cut at eight weeks after emergence and shredded (into smaller fragments of 5 cm or lesser. These materials were air-dried for 14 days to reduce the moisture content to about 6 %. The poultry manure used was obtained from Adegolu's Poultry (Layers) House, which is a Livestock Production Unit at the Teaching and Research Farms, LAUTECH, Ogbomoso. All the non-biodegradable materials like metals, stones and other foreign materials were carefully removed from the manure. The manure was later air dried for fourteen days. Samples were randomly collected from both the Tithonia plant materials and cured manure for laboratory chemical analyses using standard methods (IITA, 1982).

Experimental design

The six treatments introduced were: T0 = Zero or no fertilizer application, T1 = Application of 100% recommended dosage of NPK fertilizer (i.e. 300kgNPKha^{-1}), T2 = Application of 100% recommended dosage of Composted tithonia (i.e. 6 tonsha^{-1}), T3= Combined application of 75% recommended dosage of NPK with 25% recommended dosage of Composted tithonia, T4= Combined application of 50% recommended dosage of NPK with 50% recommended dosage of Composted tithonia, T5= Combined application of 25% recommended dosage of NPK with 75% recommended dosage of Composted tithonia, The trial was laid out in a Randomized Complete Block Design (RCBD), with three replications.

Data Collection and Statistical Analysis

Data collection commenced at three weeks after sowing (3 WAS) and ended at nine (9) weeks after sowing (9 WAS). Data were collected on growth (plant height, number of leaves, leaf area, number of branches and stem girth) and yield (Shoot fresh weight and Shoot dry weight) parameters. The growth parameters observed were; Plant height which was determined using a tape rule by placing it on the stem base and run it to the tip of the plant, Number of leaves and branches were determined by visual observation i.e. by direct counting of the fully opened leaves or well developed branches respectively. Stem girth or stem circumference was measured with aid of venier caliper, which originally measured the stem diameter, which was later converted to stem girth , stem circumference using formula πD, where D = diameter value and $\pi = 3.142$, to give the actual stem girth or circumference value. The shoot fresh and dry weights of the celosia biomass were measured with the aid of an Electronic sensitive scale or weighing balance (Model: Citizen MP500H). Data collected were analyzed using Analysis of Variance (ANOVA) at $p<0.05$. Significant means were separated using Duncan Multiple Range Test (DMRT), according to SAS (2019).

Plant sampling and analysis

The experiment was terminated at eight weeks after sowing, plant samples were oven dried at 80°C for 48 hours and analyzed, following the procedures of AOAC (1980) and Heanes, (1984). The nutrients accumulated in plant parts were calculated as; Nutrient uptake = % Nutrient content x sample dry weight according to Ombo (1994) and Gungunla (1999).

RESULTS AND DISCUSSION

Soil Physical and Chemical Characteristics

The results obtained from the pre-cropping physical and chemical soil analyses of the composite soil sample used for this experiment showed that the soil was mildly-acidic with a pH value of 6.10 (Table 1) and texturally sandy-loam with sand (848.00 gkg^{-1}), silt (79.70 gkg^{-1}) and clay (72.30 gkg^{-1}). It was also revealed that the soil was grossly low in essential nutrients with Total N (0.04%), Available P (3.80 mg kg^{-1}) and Exchangeable bases ($cmolkg^{-1}$): K (0.20), Ca (3.60) and Mg (0.38), while the Organic Carbon was at 1.78%, which is also relatively low (Table 1). These results corroborated the findings of Babajide *et al.* (2008) and Babajide (2010) which indicated that the soils at the study area was slightly acidic in nature and were also reported to be grossly low in essential nutrient concentrations which are inadequate to support arable crop growth and development. Thus, the soils generally require adequate fertilizer application to enhance arable crops' effective and efficient performances.

Effect of composted tithonia and NPK fertilizer combinations on the growth parameters of *Celosia argentea* at different weeks after sowing (WAS).

Celosia responded well to applications of both composted tithonia and NPK fertilizer, irrespective of whether it was solely applied or applied in combined proportions, as manifested in the significant enhancement of all the growth parameters measured (Table 2). Regarding the plant height, application of T2 (i.e. 100% composted tithonia) significantly improved plant height of celosia at different weeks after sowing, but the values obtained at each week were not significantly different from those of other fertilizer combinations investigated but were significantly higher than the control which had least values across all weeks of plant height determination (Table 2). Application of composted tithonia and NPK fertilizer at different levels of inclusion significantly enhanced number of branches of *Celosia argentea* (Table 3). At 6WAS, T2, T3 and T4 had significantly higher value of 8.0 as the number of branches, but the value was not significantly different from those obtained from T1 (13.0) and T5 (14.0), but the value was significantly higher than that of the control, which recorded the least value of 6.0 (Table 3). At week 7 after sowing, T2 had significantly higher value of 22 branches, which is not significantly different from all other fertilizer treatments tested but was significantly higher than the control, which has the least value. Similarly, at 8 an d 9 weeks after sowing, T2 had the significantly higher values of 31 and 35 branches respectively but the values were not significantly different from other treatments but significantly higher than the control (Table 3). Also, application of NPK and tithonia compost at different levels of inclusion significantly improved celosia foliage formation, as luxuriant vegetative growth was observed in plants which received any of the fertilizer combinations or sole applications (Table 4). In relation to the number of leaves produced, T2 had significantly higher values throughout the weeks of data collection of 69, 196, 202 and 204 for 6, 7, 8 and 9 weeks after sowing respectively. However, the values recorded for T2 were not significantly different from other levels of NPK and tithonia combinations tested, but higher than the control (Table 4). In terms of stem girth or circumference, application of different levels of NPK and tithonia combinations significantly improved the stem wideness of celosia. Application of T2 produced significantly broader stems as the significantly higher values of stem girth were observed in plants which received 100% tithonia compost throughout the weeks of data collection, although the value of T2 obtained per week was not significantly different from those obtained from other fertilizer treatments, but was significantly higher than the control (Table 5). These results are in line with the research findings of Akanbi (2002): Babajide (2010); Oyedeji *et al.*, (2014) and Umeri *et al.*,

(2022) which reported enhanced growth parameters of different arable crops through applications of different fertilizer types or different fertilizer integrations

Effect of composted tithonia and NPK fertilizer combinations on the yield parameters of *Celosia argentea*.

Application of composted tithonia and NPK fertilizer significantly enhanced yield parameters of *Celosia argentea*. Considering the shoot fresh weight (SFW), application T2 significantly enhanced fresh celosia shoot biomass, as it produced a significantly higher value of 204.6g, which is not significantly different from T1, which produced 192.2g of fresh shoot biomass of celosia, as well as T4 and T5 fertilizer treatments which produced 184.4g and 180.3g respectively, but was significantly higher than T3 which produced 176.8g and the control which had the least value of 65.8g (Table 6). Similarly, Application of composted tithonia and NPK fertilizer significantly enhanced shoot dry weight (SDW) of *Celosia argentea*. Application T2 produced significantly higher shoot dry biomass of celosia, with a value of 61.4g, which was not significantly higher than T1 with a value of 58.4g, but was found to be significantly higher than 40.6g, 48.9g and 47.8g which were respectively produced by applications of T3, T4 and T5, while the control had the least value of 19.6g (Table 6). These results corroborated the research findings of Fatima *et al*., (2007); Olaniyi *et al*., (2007); Olatoberu *et al*., (2019); Umeri *et al*., (2022) and Babajide *et al*., (2023), which reported significantly enhanced yields of some arable crop-plants which received sole and(or) combined fertilizer applications, under tropical soil conditions.

Effect of composted Tithonia and NPK fertilizer on the nutrient uptakes of *Celosia argentea*

Celosia responded well to improved soil nutrition, particularly in relation to its nutrient uptakes. The uptakes of different plant nutrients were significantly influenced by application of composted Tithonia and NPK fertilizer at different proportions, comparable to the control, which received no fertilizer application at all.

Regarding the nitrogen (N) uptake of *Celosia argentea,* T1 had the significantly higher value of 49.6gkg^{-1} but the value was not significantly different from T2 (48.2gkg^{-1}), T4 (40.8gkg^{-1}) and T5 (40.4gkg^{-1}) but significantly higher than T3 (30.5gkg^{-1}), while the control (which received no fertilizer application) had the least value of 6.2gkg^{-1}. For phosphorus (P) uptake, T2 had the significantly higher value of 19.2gkg^{-1} but the value was not significantly different from all other fertilizer treatments investigated except the control (which received no fertilizer application) had the least value of 2.7gkg^{-1}. For potassium (K) uptake, similarly, the T2 had significantly higher value of 19.0gkg^{-1}, which is not significantly different from all other treatments tested, but significantly higher than T0 (control), which had the least value of 3.6gkg^{-1}. Regarding the Ca uptake, T2 significantly improved its uptake with significantly higher value of 3.9mgkg^{-1}, which is not significantly different from the T1 (3.4mgkg^{-1}), T4 (3.7mgkg^{-1}) and T5 (3.3mgkg^{-1}), but significantly different from T3 (1.7mgkg^{-1}), while the control (T0) had the least value of 0.5mgkg^{-1}. In terms of Magnesium (Mg), T2 and T4 had significantly higher and similar value of nutrient uptake (1.9mgkg^{-1}) which was not significantly higher than T5 (1.6 mgkg^{-1}) but significantly higher than T1 (0.9mgkg^{-1}) and T3 (0.9mgkg^{-1}), while T0 had the least value of (0.3mgkg^{-1}). In relation to iron (Fe) uptake, T3 had the significantly higher value of (219.8mgkg^{-1}), which was not significantly different from T2 (217.0mgkg^{-1}) and T5 (217.6mgkg^{-1}), but significantly different from T1 (118.8mgkg^{-1}) and T4 (112.7mgkg^{-1}), but significantly higher than the control (T0), which had the least value of 78.2mgkg^{-1}. Considering the Copper (Cu) uptake, T3 had the significantly higher value of 19.2mgkg^{-1}, which was not significantly higher than T5 (18.2mgkg^{-1}) and T2 (18.6mgkg^{-1}) but significantly higher than T1 (9.9mgkg^{-1}) and T4 (9.4mgkg^{-1}), while the control had the least value of (7.8mgkg^{-1}). In contrast, zinc (Zn) uptake was significantly enhanced by the control, which had a significantly higher value of 71.2mgkg^{-1}, which was observed to be significantly higher than all other fertilizer treatments investigated (Table 4.7). These results are in support of the reported research findings of Akanbi (2002): Olaniyi (2007); Babajide (2010); Babajide (2014) and Babajide *et al*., (2023) which indicated enhanced nutrient uptakes through improved soil nutrition from different fertilizer types / different fertilizer combinations.

CONCLUSION AND RECOMMENDATIONS

Celosia argentea responded well to improved soil nutrition via fertilizer application at varying levels of inclusion of both tithonia compost and NPK fertilizer, enhanced growth and yield parameters were observed in plants which received any of the fertilizer treatments tested, comparable to the control which received no fertilizer application, in the study area. Tithonia compost is a dependable potential fertilizer material, as its applications (irrespective of the levels of inclusion with the NPK), significantly improved all the growth and yield parameters of *Celosia argentea.* Application of 100% tithonia compost effectively and successfully competed with application of NPK fertilizer at 100% recommended rate.

Growth and yield parameters of celosia improved significantly with increasing levels of tithonia compost. Although application of 100% tithonia compost at recommended rate of 6tons/ ha effectively and successfully competed with application of NPK fertilizer at 100% recommended rate of 300kg/ha, the values obtained from the measured growth and yield parameters were not (in most cases) significantly different from those obtained from other fertilizer combinations investigated in the study area. Since abusive and continuous application chemical fertilizer had been reported to be harmful to soil quality, beneficial soil microbes, crop-plants as well as imposition of threats to human health and welfare, reduced rates of chemical fertilizer materials to the tropical soils, should be adopted by local farmers. Therefore, any of the tithonia compost inclusions ranging from 50% to 100% (depending on the availability) is therefore suggested to be applied to soils by local farmers. This will definitely reduce or completely eradicate chemical loads on soils, which will eventually favour improvement of soil quality, soil productivity, as well as production of hygienically saved farm produce in the study area.

Table 1: Physical and Chemical analysis of the soil sample used

Soil Properties	Values
pH (H_2O)	6.10
Organic Carbon (gkg^{-1})	1.48
Total N (gkg^{-1})	0.04
Available P ($mgkg^{-1}$)	3.8
Fe ($mgkg^{-1}$)	15.78
Cu ($mgkg^{-1}$)	3.41
Zn ($mgkg^{-1}$)	2.92
Exchangeable K ($cmolkg^{-1}$)	0.20
Exchangeable Na ($cmolkg^{-1}$)	0.24
Exchangeable Ca ($cmolkg^{-1}$)	3.60
Exchangeable Mg ($cmolkg^{-1}$)	3.12
Sand (gkg^{-1})	848.00
Silt (gkg^{-1})	79.70
Clay (gkg^{-1})	72.30
Textual Class	Sandy loam

Table 2: Effect of composted tithonia and NPK fertilizer combination on the plant height of *Celosia argentea* at different weeks after sowing (WAS)

Treatment	WEEKS AFTER SOWING (WAS)			
	6	7	8	9
T0	28.2b	32.3b	36.8c	41.2c
T1	58.4a	63.5a	61.0ab	69.4ab
T2	62.8a	67.9a	76.2a	80.2a
T3	58.7a	62.4a	62.4ab	70.6ab
T4	57.0a	63.6a	64.8ab	69.4ab
T5	56.6a	67.8a	64.6ab	68.8ab

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost.

Table 3: Effect of Composted Tithonia and NPK fertilizer combination on the number of branches of *Celosia argentea* at different weeks after sowing (WAS)..

Treatments	WEEKS AFTER SOWING (WAS)			
	6	7	8	9
T0	6.0b	9.0b	11.0b	11.0b
T1	13.0a	19.0a	24.0a	26.0a

T2	18.0a	22.0a	31.0a	35.0a
T3	18.0a	19.0a	25.0a	30.0a
T4	18.0a	20.0a	25.0a	29.0a
T5	14.0a	18.0a	28.0a	30.0a

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost

Table 4: Effect of Composted Tithonia and NPK fertilizer combination on the number of leaves of *Celosia argentea* at different weeks after sowing (WAS).

Treatments	WEEKS AFTER SOWING (WAS)			
	6	7	8	9
T0	47.0b	58.0c	68.0c	70.0c
T1	76.0a	180.0ab	196.0a	192.0a
T2	69.0a	196.0a	202.0a	204.0a
T3	61.0a	178.0ab	187.0ab	185.0a
T4	59.0a	180.0ab	186.0ab	186.0ab
T5	51.0ab	182.0ab	184.0ab	185.0ab

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost.

Table 5: Effect of Composted Tithonia and NPK fertilizer combination on the stem girth of *Celosia argentea* at different weeks after sowing (WAS).

Treatments	WEEKS AFTER SOWING (WAS)			
	6	7	8	9
T0	1.6b	1.8b	2.2b	2.2b
T1	3.4a	4.6a	4.8a	4.8a
T2	3.6a	4.9a	5.0a	5.3a
T3	3.3a	4.4a	4.6a	5.0a
T4	3.2a	4.5a	4.7a	4.9a
T2	3.2a	4.4a	4.6a	5.0a

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost.

Table 6: Effect of composted tithonia and NPK fertilizer combination on the yield parameters of *Celosia argentea*

Treatments	Shoot Fresh Weight (gplant^{-1})	Shoot Dry Weight (gplant^{-1})
T0	65.8c	19.6c
T1	192.2a	58.4a
T2	204.6a	61.4a
T3	176.8b	40.6b
T4	184.4ab	48.9a
T5	180.3ab	47.8a

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost.

Table 7: Effect of composted tithonia and NPK fertilizer combinations on the nutrient uptakes of *Celosia argentea*

Treatments	N (gkg^{1})	P (gkg^{1})	K (gkg^{1})	Ca (mgkg^{1})	Mg (mgkg^{1})	Fe (mgkg^{1})	Cu (mgkg^{1})	Zn (mgkg^{1})
T0	6.2c	2.7b	3.6b	0.5c	0.3bc	78.2c	7.8b	71.2a
T1	49.6a	15.2a	15.0a	3.4a	0.9b	118.8b	9.9b	44.2b
T2	48.2a	19.2a	19.0a	3.9a	1.9a	217.0a	18.6a	40.5b
T3	30.5b	15.1a	17.0a	1.7b	0.9b	219.8a	19.2a	45.2b
T4	40.5ab	17.0a	16.6a	3.7a	1.9a	112.7b	9.4b	48.2b
T5	40.4ab	14.8a	16.8a	3.3a	1.6a	217.6a	18.2a	48.2b

Means followed by same letters are not significantly different at P=0.05, using Duncan Multiple Range Test (DMRT). T0 = the control, which received none of the fertilizers, T1 = 100% NPK, T2 = 100% Tithonia compost, T3 = 75% NPK + 25% Tithonia compost, T4 = 50% NPK + 50% Tithonia compost and T5 = 25% NPK + 75% Tithonia compost.

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