The Effects of Organic Manures and Harvesting Types in Two Seasons for Yield and Yield Contributing Agronomic Traits in Celosia (*Celosia argentea* L.)

Ehizogie Joyce FALODUN (✉)
Erigha AKPOMUAIRE
Oluwaseyi Precious ABIDAKUN

Summary

The effect of harvesting, H1 (Non- cut and uproot at 40 days after transplanting), H2 (harvest at 40 days and uproot at 55 days after transplanting), H3 (harvest at 40 and 55days after transplanting and uprooting 70 days after planting) and four rates (0, 10, 15 and 20 t ha^{-1}) of poultry manure application on growth, yield and nutrient uptake of *Celosia argentea* was evaluated for two years. The trial was a 3 x 4 factorial laid out in a randomized complete block design (RCBD) in three replications. Poultry manure significantly $p < 0.05$) increased all the parameters above the control. H2 increased the number of leaves, branches and root length significantly in both years and nutrient uptake was the highest at 15 t ha^{-1} poultry manure application except for Ca which increased up to 20 t ha^{-1}. N uptake (42.31 kg ha^{-1}) was highest at H2 while P (9.43 kg ha^{-1}), K (41.13 kg ha^{-1}), Ca (34.33 mg $100g^{-1}$), Mg (19.07 mg $100g^{-1}$), Na (4.98 mg $100g^{-1}$) and Fe (1302.01 mg $100g^{-1}$) uptakes were highest at H3. The highest herbage yield (13.29 t ha^{-1} and 12.80 t ha^{-1}) was produced at H2 in both years at 10 t ha^{-1} while seed yield (36.61 t ha^{-1}) was the highest at H1 and 20 t ha^{-1} poultry manure.

Key words

nutrient uptake, root length, harvest, seed yield, leaves

Department of Crop Science, University of Benin, Nigeria

✉ Corresponding author: ehizogie.falodun@uniben.edu

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Introduction

Celosia argentea L. commonly known as Celosia belongs to the family Amaranthaceae. It is an important leafy vegetable crop grown in tropical and sub-tropical regions of the world. The leaves are very succulent and serve as an excellent source of protein, calcium, iron, vitamins A and C. (Denton, 2004).

In Nigeria, apart from *Celosia* uses as a vegetable, its seeds extract have traditionally been used as a therapeutic drug for eye and hepatic diseases in China and Japan. Presently in Nigeria, the vegetable supply to areas of high demand has remained low (Adewole, and Dedeke, 2012). Some of the problems encountered by vegetable growers in Nigeria are the low soil fertility and lack of capital to buy chemical fertilizers for optimum crop productivity (Olufolaji et al., 1990). Most African soils are inherently low in organic carbon, slightly acidic and relatively sandy. Ayoola and Adeniyan (2006) reported that the use of inorganic fertilizers had not been helpful in agriculture. Continuous and intensive use of highly priced synthetic fertilizer materials for boosting crop productivity in the past decades has also been linked to the decline in tropical soil fertility, hence crop productivity has become a major concern and indeed a great hindrance to achieving food sufficiency in the tropics (Babajide and Olla, 2014). The use of inorganic fertilizers has been reported to influence nutrient imbalances, nitrate pollution, microbial activities, soil acidity and pose fatal threats to man (Sobulo, 2000; Akanbi, 2002). It is important to provide an alternative source of nutrients for effective and efficient crop production (Akanbi et al., 2007; Chukwuka and Omotayo, 2009). The production and consumption of poultry products will continue to increase relative to the world's growing human population need for improved life quality (Williams et al., 1999; Zhang et al., 2007). Consequently, environmental impacts of waste by-products of poultry industries are of increasing importance worldwide and the disposal of these wastes is a major environmental problem related to intensive livestock production. Agro-industrial wastes such as poultry manures if converted to organic fertilizers could minimize the environmental hazard they may pose (Ayeni, 2010). The use of poultry manure for the growth and yield of vegetables and other crops is common with farmers in the tropics and has been advocated to compensate for the export of soil nutrients because of their low cost and availability (Moyin-Jesu, 2002). Poultry manure helps to improve the physical conditions of the soils and provides adequate amount of necessary nutrients for soil productivity and nutrient uptake, in addition to being a major contributor of plant nutrient (Adeyeye, 2009). Falodun and Egharevba (2017) reported an increase in bulb yield, nutrient concentration and uptake of onion plant with an increase in the rate of nutrient applied and stated that optimum level of nutrient uptake was obtained at 10 t ha^{-1} of either poultry or swine manure. They further stressed the need to encourage farmers in the use of organic manure in vegetable production. The type of harvesting method employed by growers to improve the yield of *Celosia* is on the increase. Different methods have been used to harvest vegetables, they could be uprooted or cut in a way that lower leaves are left un-harvested (Adediran et al., 2015). Repeated cutting or harvesting encourages the production of side shoots for further cuttings while flowering is delayed. Currently, there is a dearth of information on the growth performance, yield and nutrient uptake of *Celosia* (*Celosia argentea* L.) as influenced by poultry manure and harvesting types. This study, therefore, sought to assess the agronomy and nutrient uptake of *Celosia argentea* under different application rates of poultry manure and harvesting types.

Materials and Methods

Experimental Site and Meteorology

Two consecutive field studies were conducted at the Experimental Farm of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria between 2017 - 2019 cropping seasons. The location lies between latitude 6° 14' N and 7° 34' N and longitude 5° 40' E and 6° 43' E at an elevation of 162 m above sea level. The daily temperature is about 26.5 °C and the monthly rainfall distribution pattern for the area is bimodal with peaks in June and September. Annual rainfall ranges from 1200 to 1450 mm spanning over eight months (March to October) with a dry spell in August. The dry season is from November to March. The part of the farm that the experiment was conducted on had been overgrown with sensitive plant (*Mimosa pudica*), spear grass (*Imperata cylindrica*) and guinea grass (*Panicum maximum*).

Soil Samples and Analysis

The composite soil sample (0-15 cm depth) taken from the site was air-dried in laboratory, ground, sieved through a 2 mm sieve and analysed for its routine soil physical and chemical properties using standard laboratory procedures outlined by Mylaravapus and Kennelley (2002). The soil routine analysis showed that it had pH (H_2O) of 5.65, 18.36% organic carbon, 0.04% of total nitrogen, 6.06 mg kg^{-1} of available phosphorus; 0.26 cmol kg^{-1} of exchangeable Mg, 0.14 cmol kg^{-1} of exchangeable K, 0.58 cmol kg^{-1} of exchangeable Ca, 5.50% of clay, 5.30% of silt and 89.20% of sand. The results of the chemical analysis of cured poultry manure used for the trials showed that it had 24.07% of organic matter, 2.14 % of total nitrogen, 0.84% of available phosphorus, while the K, Ca and Mg were 1.92, 0.75 and 0.13 cmol kg^{-1} , respectively.

Sources of Planting Materials

The seeds and poultry manure used for the trial were obtained from the Faculty of Agriculture, Department of Crop Science and from the University of Benin Farm Project respectively.

Experimental Design

The trial was a 3 x 4 factorial laid out in a randomized complete block design (RCBD) in three replications. Three systems of repeated harvest, H1 (uproot at 40 days after transplanting), H2 (harvest at 40 days and uproot at 55 days after transplanting), H3 (harvest at 40 and 55 days after transplanting and uprooting 70 days after transplanting) and four rates (0, 10, 15 and 20 t ha^{-1}) of poultry manure application made up the treatments. The land was manually cleared of existing vegetations and debris worked into the soil with a hoe. Seeds of *Celosia argentea* were sown in the nursery by broadcasting and seeds germinated with emergence of seedlings 5 days after sowing (DAS). The seedlings remained in the nursery for three weeks with routine management like watering and weeding when necessary, after which they were transplanted to the field. Raised beds measuring 1.0 m x 1.0 m per plot were constructed and used in the field. Each plot carried a treatment. The poultry manure used for the trial was cured for two weeks before it was applied to the field. Poultry manure rates (0, 10, 15 and 20 t ha^{-1}) were applied and incorporated into the soil in the field depending on the treatments and watered thoroughly before transplanting. Three weeks old *Celosia argentea* seedlings were transplanted at a spacing of 25 cm x 25 cm to give plant-ing density of 160,000 plants ha^{-1}, the plots were watered and carefully mulched with dry grasses after transplanting. Seedlings were supplied to missing stands a week after transplanting (WAT). The weeding was done in 2, 4 and 6 weeks after transplanting (WAT).

Sampling and Measurement

Plant growth was monitored in-situ from four randomly sampled plants per plot using conventional growth indices such as number of leaves, number of branches, plant height, stem diameter and leaf area. Plant height was taken at four WAT only. Harvesting of plant was done by cutting the plants at 20 cm above soil surface. This was done according to the treatments. The cumulative herbage fresh yield was determined at the end of the last harvest for all the treatment except for the non-cut plant treatment in which shoot harvesting was done once at 40 DAT and used to estimate its herbage fresh yield in (t ha^{-1}). For dry herbage yield, fresh shoot samples were chopped and packed inside well labelled envelopes and dried in oven at 70 °C till constant weight was attained. This was done periodically (for the cut plants) and in total dry herbage yield (for non – cut plants). The dried samples were then weighed using a sensitive electronic balance and the weight was recorded. The cumulative dry herbage yields were obtained by adding together individual value obtained at each harvest and estimated in (t ha^{1}).

Determination of Tissue Nutrient Concentration and Uptake

Harvested leaves were cleaned of soil particles with distilled water and air dried and weighed with a sensitive balance. The leaves were chopped into small bits and packed inside well labelled envelopes and oven dried in a forced-Air Sanyo Gallen kamp moisture extraction oven at 70 °C to a constant weight (ISTA, 1993). The dried samples were weighed using a sensitive electronic balance and the weight was recorded. These were milled to pass through 0.2 mm sieve using Thomas Wiley Hammer Mill in preparation for laboratory analysis. Calcium (Ca), Sodium (Na), Magnesium (Mg), Iron (Fe), Nitrogen (N), Phosphorus (P) and Potassium (K) were determined. The analytical procedures for the nutrients were as described by AOAC (1980). The total N and P concentrations were determined using Kjeldahl and photometric methods respectively while K, Ca, Fe, concentrations were measured by atomic absorption spectrophotometer. Nitrogen, P, K, Ca, Na, Mg, and Fe uptakes were calculated using the formula:

Nutrient uptake = oven dry weight of tissue x nutrient content in plant tissue (%).

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA), using SAS (Statistical Analysis Software) and the Least Significant Difference (LSD) test was used to compare the significant differences between means at $P \leq 0.05$.

Results

Soil and Manure Properties

The data on the physico-chemical properties of the soil used for the experiment is presented in Table 1. The textural class showed that the soil was sandy loam and low in fertility as reflected by the low content of organic matter (0.75 g kg^{-1}), and total nitrogen (0.03 g kg^{-1}). The soil pH was strongly acid with a mean value of 5.30. The available phosphorus (24.15 mg kg^{-1}) was high, potassium with mean value of (0.16 cmol kg^{-1}) was seemingly low based on the ratings of the recommended critical concentration levels of 0.34 cmol kg^{-1} for K and 0.15% N. The total P content (24.15 mg kg^{-1}) of the soil was higher than the recommended critical value of 10 – 16 mg kg^{-1} for the ecological zone (Table1).

Table 1. Chemical composition of the soil used for the experiment

Parameter	Value
pH(H_2O)	5.30
Organic matter (g kg^{-1})	0.75
Total N (g kg^{-1})	0.03
Available P (mg kg^{-1})	24.15
K (cmol kg^{-1})	0.16
Ca (cmol kg^{-1})	0.85
Mg (cmol kg^{-1})	0.63
Sand (%)	80.87
Clay (%)	13.72
Silt (%)	5. 41
Textural class	Sandy loam

The low fertility status of the soils necessitated the need for soil amendment. The results of the chemical analysis of poultry manure revealed nutrient rich source for the growth and development of vegetable crops (Table 2). In both cropping seasons, the effect of poultry manure on plant height, number of leaves and leaf area was significant. In 2017/18 cropping season, poultry manure increased plant height from (10.04 -16.23 cm), number of leaves (48.96 – 77.51) and leaf area from (20.10 - 29.82 cm^2). In 2018/19 cropping season, all the vegetative characteristics were significantly ($P < 0.05$) increased by poultry manure application (Table 3). All the plants that received poultry manure were statistically similar and were increased above the control which received no manure.

Table 2. Chemical composition of the poultry manure used for the experiment

Parameter	Value
pH(H_2O)	6.13
Organic matter (g kg $^{-1}$)	23.62
Total N (g kg $^{-1}$)	2.41
Available P (mg kg $^{-1}$)	0.83
K (cmol kg $^{-1}$)	1.62
Ca (cmol kg $^{-1}$)	0.85
Mg (cmol kg $^{-1}$)	0.12
Na (cmol kg $^{-1}$)	0.35

The plant height (26.78 - 43.30 cm), number of leaves (42.64 - 64.08), stem diameter (2.65 – 3.36 cm) and number of branches (18.11 - 46.5) increased when poultry manure was increased from 0 - 10 t ha^{-1} poultry manure. The leaf area (50.07 cm^2) increased up to 10 t ha^{-1} and decreased (38.65 cm) at 20 t ha^{-1} (Table 3). Root length increased from (14.21 cm – 15.03 cm) and (10.18 cm – 12.95 cm) when poultry manure rate was increased from 0 - 10 t ha^{-1}, while the root weight (13.13 g) and (10.25 g) increased up to application rate of 15 t ha^{-1} in 2017/18 and 2018/19 cropping seasons respectively. Fresh, dry herbage and seed yields were increased by poultry manure application (Table 4). Application rate of 10 t ha^{-1} in 2018/19 significantly ($P < 0.05$) produced the highest fresh herbage yield (13.09 t ha^{-1}), dry (3.53 t ha^{-1}) and seed yield (27.55 t ha^{-1}) increased with an increase in rate of poultry manure application up to 20 t ha^{-1}, (Table 4). Observations from the trial showed that application rate of 15 t ha^{-1} significantly increased nutrient uptake of all the elements that were sampled except for Ca which increased from 18.52 kg ha^{-1} – 28 .81 kg ha^{-1} when poultry manure was increased from 10 t ha^{-1} to 20 t ha^{-1}. (Table 5). Similarly, in 2017/18, the effects of repeated harvests on plant height, number of leaves and branches were significant. Repeated harvests at H2 and H3 produced statistically similar plant heights (18.75 cm and 19.11 cm) which were taller than that (9.99 cm) produced by H1. Number of leaves (68. 61) was the highest at H3 and the lowest (32.54) at H1. Number of branches followed the same pattern in both years and increased with the increase in repeated harvests from H1 (17.98) to H2 (27.62). Increasing the harvest to H3 did not result in a significant increase in the number of branches (23.66). The highest fresh herbage yield (13.29 t ha^{-1}and 12.80 t ha^{-1}) was produced at H2 while seed yield (36.61 t ha^{-1} and 25.35 t ha^{-1}) was the highest at H1 and at 20 t ha^{-1} poultry manure in both years, (Table 2).

Repeated harvest at H2 produced a significantly higher root length (22.15 cm) above H1 which produced (11.43 cm). Root weight per plant was higher and similar at H2 (16.61 g) and H3 (12.96 g) and these observations were similar in both years.

Table 3. Effect of repeated harvests and fertilizer application on some vegetative characters of *Celosia argentea*

Treatment	2017/2018 Cropping season					2018/2019 Cropping season				
	Plant height (cm)	Number of leaves	Number of branches	Stem diameter (cm)	Leaf area (cm^3)	Plant height (cm)	Number of leaves	Number of branches	Stem diameter (cm)	Leaf area (cm^3)
Poultry manure (t ha $^{-1}$)										
0	10.04b	48.96b	22.77a	1.63a	20.10b	26.78b	42.64b	18.11b	2.65b	38.99b
10	15.91a	69.28a	23.16a	1.49a	28.37a	43.30a	64.08a	26.47a	3.36a	50.07a
15	16.23a	72.15a	23.24a	1.28a	29.82a	38.83a	59.55a	24.16a	3.27a	44.56ab
20	15.71a	77.51a	23.32a	1.48a	26.48ab	42.61a	62.95a	25.44a	3.21a	38.65b
LSD	2.79	12.71	7.78	1.40	7.12	8.93	10.54	3.65	0.32	10.93
Significance	*	*	N.S.	N.S.	*	*	*	*	*	*
Repeated harvests										
H1	9.99b	32.54c	17.98b	1.43a	33.71a	40.22a	53.48b	22.56b	3.09a	44.70a
H2	18.75a	54.60b	27.62a	1.74a	26.18a	36.21a	62.15a	25.77a	3.23a	42.96a
H3	19.11a	68.61a	23.66ab	1.44a	24.07a	27.20a	56.29ab	23.31ab	3.05a	41.54a
LSD	2.79	10.71	7.78	1.40	12.12	7.73	9.13	3.16	0.28	9.47
Significance	*	*	*	N.S.	N.S.	N. S.	*	*	N. S.	N. S.

Note: Means followed by the same letters along rows are not significantly different at $P \leq 0.05$ level, * – significant at $P \leq 0.05$ level, N.S. - non-significant, H1: Uprooting at 40days after planting H2: Cut at 40days after planting and uproot at 55days, H3: Cut at 40 and 55days after planting and uproot at 70days

Table 4. Effect of repeated harvests and fertilizer application on some reproductive characters of *Celosia argentea*

Treatment	2017/2018 Cropping season					2018/2019 Cropping season				
	Root Length (cm)	Root weight (g)	Fresh herbage yield (t ha $^{-1}$)	Dry herbage yield (t ha $^{-1}$)	Seed yield (t ha $^{-1}$)	Root Length (cm)	Root weight (g)	Fresh herbage yield (t ha $^{-1}$)	Dry herbage yield (t ha $^{-1}$)	Seed yield (t ha $^{-1}$)
Poultry manure (t ha $^{-1}$)										
0	14.21b	10.09b	8.30b	2.73b	12.13c	10.18b	8.14b	7.59b	2.08a	12.67c
10	15.03ab	11.15b	12.22a	3.50a	17.22b	12.95a	8.82b	13.09a	3.53a	17.55b
15	17.15a	13.13ab	12.41a	3.86a	20.69b	13.91a	10.25a	11. 43ab	2.77a	20.47b
20	17.64a	13.74a	13.66a	4.17a	25.83a	13.62a	10.56a	12.52ab	3.52a	26.04a
LSD	2.61	2.10	2.99	1.29	5.07	2.01	1.12	5.34	1.62	4.07
Significance	*	*	*	*	*	*	*	*	N.S.	*
Repeated harvests										
H1	22.15a	16.82a	6.39b	2.04b	25.35a	14.25a	10.67a	9. 21b	2.12a	36.61a
H2	18.21ab	12.61a	12.80a	3.46a	18.11b	15.23a	12.48a	13.29a	3.71a	15.53b
H3	11.06b	7.96b	15.88a	3.26a	12.28c	12.01b	8.15b	10.98a	2.59a	14.66b
LSD	8.61	4.20	3.99	1.02	5.97	2.03	2.12	3.62	1.4	9.33
Significance	*	*	*	*	*	*	*	*	N.S.	*

Note: Means followed by the same letters along rows are not significantly different at $P \leq 0.05$ level, * – significant at $P \leq 0.05$ level, N.S. - non-significant, H1: Uprooting at 40days after planting H2: Cut at 40days after planting and uproot at 55days, H3: Cut at 40 and 55days after planting and uproot at 70days

Table 5. Effect of fertilizer application and repeated harvest on nutrient uptake of *Celosia argentea*

Treatment	Nutrient uptake (kg ha $^{-1}$)						
	N	P	K	Ca	Mg	Na	Fe
Poultry manure (t ha $^{-1}$)							
0	25.04c	5.06c	25.30c	20.85b	11.82c	2.06c	727b
10	25.08b	5.42b	28.89b	18.52c	13.77b	3.89b	653c
15	34.15a	10.44a	36.19a	20.21b	18.65a	5.04a	1216a
20	42.14a	12.44a	42.25a	28.81a	18.84a	5.08a	1224a
Significance	*	*	*	*	*	*	*
Repeated harvests							
H1	22.29c	4.00c	17.24c	10.10c	7.28c	1.74c	357c
H2	42.31a	9.43b	38.08b	23.71b	17.90b	4.27b	937b
H3	29.66b	9.48a	41.13a	34.33a	19.07a	4.98a	1302a
Significance	*	*	*	*	*	*	*

Note: Means followed by the same letters along rows are not significantly different at $P \leq 0.05$ level, * – significant at $P \leq 0.05$ level, H1: Uprooting at 40days after planting H2: Cut at 40days after planting and uproot at 55days, H3: Cut at 40 and 55days after planting and uproot at 70days

The increase in repeated harvest decreased seed yield in this pattern H3 < H2< H1. Significantly ($p < 0.05$), the highest seed yield (25.35 t ha^{-1} and 36.61 t ha^{-1}) was obtained at H1 in 2017/18 and 2018/19 cropping seasons respectively. N uptake (42.31 kg ha^{-1}) was the highest at H2 while P uptake was (9.43 kg ha^{-1}), K (41.13 kg ha^{-1}), Ca (34.33 mg $100g^{-1}$), Mg (19.07 mg $100g^{-1}$), Na (4.98 mg $100g^{-1}$) and Fe (1302.01 mg $100g^{-1}$) and was the highest at H3, compared with H1 and H2. Increasing the harvesting times resulted in a higher nutrient uptake of P, K, Ca, Mg, Na and Fe for *Celosia*.

Discussion

The result of the soil analysis used for the experiment showed that the soil was deficient in the essential plant nutrients needed for optimum growth and development of crops except for P. This assertion is based on the recommendation of Agboola and Ayodele (1985) who reported the critical concentration levels of 3, 0.15%, 8-10 mg kg^{-1}, 0.2 cmol kg^{-1}, 2.0 cmol kg^{-1}, and 0.26 cmol kg^{-1} for soil organic matter, N, P, K, Ca and Mg respectively. The increase in the vegetative character as a result of increase in poultry manure application could be due to the essential nutrients contained in this manure. Falodun and Ogedegbe (2020) reported the superiority of poultry and swine manure over cow dungs in improving tomato growth and yield. Similar results were obtained by Nweke and Nsoanya (2015) who in their work ascribed the increase in cucumber fruits due to the application of poultry manure which is a rich source of nitrogen, phosphorus, magnesium and calcium. Senjobi et al., (2010) stated that poultry manure improved some of the growth parameters of the leaf vegetable resulting in high leaf production. The result of this experiment supports the finding of Sanni et al., 2014 who found higher yields for *Celosia* when poultry manure was increased from 0 – 25 t ha^{-1}. The increase in nutrient uptake with the increase in manure application up to 10 t ha^{-1} might be due to the high concentration of nutrients in high poultry manure level. This shows that there is a direct relationship between levels of manure application and nutrient uptake and this is in line with earlier findings (Pachauri et al., 2005). The lowest values obtained from the control plants which received no manure could result from the fact that the plants had to depend mainly on the intrinsic soil fertility. These observations from the trial reveal that organic fertilizers are valuable fertilizers for any farming operation because of their ability to supply needed nutrients for crop growth. The increase in agronomic characters of most of the parameters measured as a result of harvesting at H2 and H3 could probably be seen as a result of the method of harvesting that enhanced the re-growth of the side shoots, which might have caused the plants to absorb more nutrients from the soil. Harvesting at H2 and H3 was observed to produce higher shoot yield when compared to the situation in which the plants were uprooted only. This could be attributed to dry matter accumulation with an increase in plant age as supported by Mahala et al. (2012). The highest seed yield recorded at H1, supports the findings of Mbwambo et al. (2015) who evaluated leaf and grain yields of amaranths under 3-4 leaf harvests and under no-leaf harvest. They reported that leaf harvest reduced average grain yields of amaranth by 25.5%). The higher nutrient uptake of N, P, K and Mg at H2 and H3: (planting H2: cut at 40days after planting and uproot at 55days, H3: cut at 40 and 55days after planting and uproot at 70days.) might be due to the fact that the plants absorbed more nutrient from the soil for re- growth of side shoots and the absorbed nutrients might have translocated to the leaves that were harvested.

Conclusion

Harvesting at H2 and H3 was observed to produce higher shoot yield and increased nutrient uptake compared with the situation in which the plants were uprooted only. The highest seed yield was recorded with H1 at 20 t ha^{-1} poultry manure while the highest herbage yield was produced at H2 in both years at 10 t ha^{-1}. Nutrient uptake was the highest at 15 t ha^{-1} poultry manure application except for Ca, which increased up to 20 t ha^{-1}.

References

Adediran Z., Gana O. A., Oladiran J. A., Ibrahim H. (2015). Effects of Age at Harvest and Leaf Position on the Yield and Nutritional Composition of *Celosia argentea* L. Int J Plant Soil Sci 5 (6): 359 –365. doi: 10.9734/IJPSS/2015/15063

Adewole M. B., Dedeke G. O. (2012). Growth Performance, Yield and Nutritional Quality of *Amanranthus cruentus* L. under Repeated Applications of Poultry Manures. Ife J. Sci 14 (2) 345 – 356

Adeyeye A. S. (2009). Pod Shattering Attributes and the Responses of Soybean (*Glycne max* L. Merrill) to Compost, Nitrogen Fertilizer and Rhizobium Inoculation. PhD, Department of Crop Protection and Environmental Biology, University of Ibadan

Agboola A. A., Ayodele O. J. (1985). Prospects and Problems of Using Soil Testing for Adoption of Fertilizer Use in Ekiti- Akoko Agricultural Development Area. Proceedings of the Workshop on Appropriate Technologies for Farmers in Semi-Arid West Africa, April 2-5, 1985, Purdue University West Lafeyette, pp: 123-126.

Akanbi W. B., Olaniran O.A., Olaniyi J.O., Ojo M.A., Sanusi O.O. (2007). Effect of Cassava Peel Compost and Nutritional Quality of *Celosia* (*Celosia argentea* L.). Res J. Agron 1 (3): 110-115

AOAC (1980). Association of Official Agricultural Chemists. Officials and Tentative Methods of Analysis. 11th Ed. Washington, D.C. USA.

Ayeni L. S. (2010). Effect of Combined Cocoa Pod Ash and NPK Fertilizer on Soil Properties, Nutrient Uptake and Yield of Maize. J Am Sci. 6 (3): 79-84

Ayoola O. T., Adeniyan O. N. (2006). Influence of Poultry Manure and NPK Fertilizer on Yield and Yield Components of Crops under Different Cropping Systems in Southwestern Nigeria. Afr J. Biotechnol. 5 (15): 1386-1392

Babajide P. A., Olla N. O. (2014). Performance of Indigenous *Celosia argentea* Variety and Soil Physico-Chemical Properties as Affected by Dual Application of Compost and Single N-Mineral Fertilizer in Southern Guinea Savanna Vegetation Zone of Nigeria. J Biol Agric Healthc 4 (19): 69-74

Chukwuka K. S., Omotayo O. E. (2009). Soil Fertility Restoration Potentials of Tithonia Green Manure and Water Hyacinth Compost on a Nutrient Depleted Soil in South West Nigeria. Res J. Soil Biol 1(1): 20-30

Denton O. A. (2004). *Celosia argentea*. In: Grubben, G.J.H. & Denton, O.A. (Eds.) PROTA4U, PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands.

Falodun EJ and Egharevba R. K. A. (2017). Nutrient Concentration, Uptake and Yield of Onion (*Allium cepa* L.) as Affected by Manure Types and Rates of Application. J Agric Forestry Fish 16 (2): 14 -17.

Falodun E. J., Ogedegbe S. A. (2020). Response of Tomato (*Lycopersicon esculentum* Mill) Varieties to Different Animal Manure. Agric Conspec Sci 85 (4): 311 – 317

ISTA (1993). International Rules for Seed Testing Association. Supplementary Rules, Seed Science and Technology. Vol. 21

Mahala A. G., Amasiab S. O., Yousif A. M., Elsadig A. (2012). Effect of Plant Age on DM (Dry Matter) Yield and Nutritive Value of Some Leguminous Plants (*Cyamopsis tetragonoloba*), *Lablab purpureus* and Clitoria (*Clitoria ternatea*). International Research Journal of Agricultural Science and Soil Science 2 (12): 502–508

Mbwambo O., Abukutsa-Onyango M. O., Dinssa F. F., Ojiewo C. (2015). Performances of Elite Amaranth Genotypes in Grain and Leaf Yields in Northern Tanzania. J Hortic. 7: 16–23. doi: 10.5897/JHF2014.0377.

Moyin-Jesu E. I. (2002). Use of Plant Residues for Improving Soil Fertility, Pod Nutrients, Root Growth and Pod Weight of Okra (*Abelmoschus esculentus* L.). Bioresour Technol 98 (11): 2057-2064. doi: 10.1016/j.biortech.2006.03.007

Mylavarapu R. S., Kennelley D.E. (2002). UF/IFAS Extension Soil Testing Laboratory (ESTL): Analytical Procedures and Training Manual. Institute of Food and Agric Sciences. University of Florida. Gainesville. U.S.A. p. 28

Nweke I. A., Nsoanya L. N. (2015). Effect of Cow Dung and Urea Fertilization on Soil Properties, Growth and Yield of Cucumber (Cucumis sativus L). J Agric Ecol Res Int. 3 (2): 81-88. doi: 10.9734/JAERI/2015/14084

Olufolaji A. O., Kayode P. A., Adeyemi O. (1990). Fertilizer Effect on the Growth and Yield of Grain Amaranths. Annual Report, National Horticultural Research Institute, Ibadan. p. 89.

Pachauri S.P., Singh V., Pachuauri C. P. (2005). Effect of FYM, Nitrogen and Potassium on Growth, Yield and Quality of Onion. Ann Plant Soil Res. 7 (1): 54 – 56

Sanni K. A., Fawole I. A., Ogunbayo S., Tia D. D., Somado E.A., Futakuchi K., Sie M., Nwilene F. E., Guei R. G. (2014). Multivariate Analysis of Diversity of Land Race Rice Germplasm. Crop Sci 52:494-504. doi: 10.2135/cropsci2010.12.0739

Senjobi B. A., Peluola C.O., Senjobi C.T., Lawal I. O., Ande O. T., Salami B. T. (2010). Performance of Cochorus olitorius as Influenced by Soil Type and Organic Manure Amendments in Yewa North Local Government Area, Ogun State. African J Biotech 9 (33): 5309-5312

Subolo R.A. (2000). Fertilizer Use and Soil Testing in Nigeria. In: Agronomy in Nigeria 2000 Edition, pp. 195 – 201.

Williams C. M., Barker J. C., Sims J. T. (1999). Management and Utilization of Poultry Wastes. Rev Environ Contam Toxicol. 162: 105-157. doi: 10.1007/978-1-4612-1528-8_3

Zhang Z., Zhang J. Y., He R., Wang Z. D., Zhu Y. M. (2007). Phosphorus Interception in Floodwater of Paddy Field during the Rice Growing Season in TaiHu Lade Basin. Environ Pollut. 145: 425- 433. doi: 10.1016/j.envpol.2006.05.031

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