**The Effects of Organic and Inorganic Fertilizers on the Growth Performance of *Celosia argentea* L.**

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**Abstract:** Pot experiments were conducted to determine the effects of organic and inorganic fertilizers on the growth of *Celosia argentea* L. The experiment was laid in Completely Random Design with five treatments. NPK and Urea (200kgha-1) and 6t ha-1of cow dung and poultry manure were used. The results revealed that cow dung manure treated seedlings produced the highest growth at 6 weeks after transplanting (6WAT) followed by poultry manure. Urea fertilizer produced the highest number of leaves at harvest. NPK fertilizer produced the highest leaf area. NPK, Urea and poultry manure had similar stem girth. Urea treated seedlings had the highest number of green leaves. NPK fertilizer treated seedlings showed the highest number of spikes followed by poultry manure. Cow dung treated seedlings with NPK had the similar relative growth rates. All the parameters accessed showed that the control experiments had the least growth. Statistical analyses (ANOVA, P < 0.05) showed that significant differences were observed in the growth parameters studied when the treatments were compared to the control experiment except the relative growth rate that showed no significant difference from the control experiment. It was observed that organic fertilizer performed better in some parameters accessed on the growth of *C. argentea*. It is suggested that organic fertilizers (poultry and cow dung) might be a good option of fertilizers in the cultivation of this vegetable by the farmers who cannot afford the price of inorganic fertilizers.

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**Keywords**: *Celosia argentea*, poultry manure, NPK, cow dung, urea

**1. Introduction**

The consumption of indigenous leafy vegetables in south western Nigeria has greatly reduced due to urbanization and increased population. Urbanization led to deforestation of agricultural lands for construction of social amenities such as schools, hospitals, stadia and so on. The traditional farming system of shifting cultivation and related bush fallow that required soil nutrients to be regained over period of years is no longer attainable. Deforestation and reduced fallow period might justify the reason why the indigenous vegetables are fading off. Also, people’s choice is now shifting from indigenous vegetables to exotic ones planted in urban areas.

The reduced fallow period and continuous cropping of farmlands lead to soil nutrients depletion that reduced the yield of crops and vegetables. The depleted soil needs to be ameliorated with fertilizer to increase the growth and yield of these crops and vegetables (Oroka, 2012). The use of naturally produced fertilizer is now globally advocated because the products from it are considered safe for humans (Fabiyi *et al*., 2015). Also, Law-Ogbomo *et al*. (2011) noted the complementary use of organic and inorganic fertilizers have been proved to be a sound soil fertility management strategy.

The indigenous vegetables had been reported to have an important role in a well-balanced diet (Vaishli and Varsha, 2013). They are nutritious with protein or fat (Whitaker, 2001). They contain various proportions of vitamins, dietary minerals and carbohydrates with other nutrients (Kratzer and Vohra, 1986, Faber *et al*., 2002 and Gruda, 2005). Vaishli and Varsha (2013) noted that indigenous leafy vegetables are good source of nutrition at low cost and are easy to cook as it gives a very good taste even without addition of additives. They provide a well-balanced diet in the recent years where lesser amount of red meat and more vegetables and fruits are advocated (Arne *et al*., 1996 and Lucarini and Canali, 1996). They played a vital role in the nutrition and the health status of the under-privileged in both rural and urban areas (Haddad, 2003 and Oniango *et al*., 2003).

The increased decline in soil fertility and crop productivity in the tropics necessitated the use of inorganic fertilizer to boast crop productivity. The continuous use of inorganic fertilizers have been reported to influence nutrient imbalance, nitrate pollution, microbial activities, soil acidity and fatal threats to man and yield reduction (Akanbi 2002, Babajide *et al*., 2008 and Ajilore, 2008).

The trend in the world today is shifting towards the use of organic fertilizers in the production of agricultural crops vegetables. The consumption of organically produced food is safer for the health status of mankind (Fabiyi *et al*., 2015). Law- Ogbomo and Ajayi (2009) noted that there was an increase demand for vegetables in urban areas where people are not involved in its primary productivity.

Akanbi *et al*. (2007) and Chukwuka and Omolayo (2009) had earlier reported the sustainability of organic materials such as crop residues and animal manure as potential sources of nutrients of inorganic fertilizer. Organic fertilization has been reported to produce better yields of crops that keep longer and more nutritious than inorganic fertilizers (Yinda and Adeoye, 1994; Adediran *et al*., 1999). Organic fertilizer improves soil physical and microbial activities, eliminates pollution and supply plant nutrients, acts as a major contributor to the cation exchange capacity and as a buffering agent against undesirable fluctuations (Olaniyi and Ojetayo, 2012).

Weber *et al*. (2007) and Asgharipour (2012) noted that organic matter possess many desirable properties such as high water holding capacity, enhanced nutrient uptake and beneficial effects on the physical, chemical and biological characteristics. The high cost of inorganic fertilizer and its associated problems such as hazardous environmental consequences necessitated the alternative methods of improving the soil nutrients with naturally produced organic fertilizer. Oyedeji *et al*. (2014) noted that inorganic fertilizers are uneconomical and is out of reach to the poor resource farmers who dominate the Nigeria Agricultural sector.

*Celosia* *argentea* (Lagos spinach) is a leafy vegetable with high nutritious value (Aladesanwa *et al*., 2001). It belongs to the family Amaranthaceae. It is a leafy vegetable popularly known in south western Nigeria (Schippers, 2000). It is commonly found in traditional intercropping system of the tropics (Olufolaji and Ayodele, 1998). It thrives well in well-drained soil with a pH of 6-6.4 (Gill *et al*., 1999). The leaves and young shoots are succulent, rich in protein, vitamins and minerals such as calcium, phosphorus and iron and are used in soup (Akanbi *et al*., 2007., Akinyemi andTijani- Eniola, 1997). Also Babajide and Olla (2014) noted that boiled shoots are served with yam or yam flour, rice and so on. The leaves and flowers are edible and are grown for such in Africa and south Asia (Gruben and Dentou, 2004).

*C. argentea* has medicinal values in treating dysentery, diarrhoea, acute abdominal pain, inflamed stomach and skin eruptions such as snakebite and wounds (Schippers, 2000) and other traditional uses(Koh *et al*., 2009). Aruna (2009) noted that the leaves of *C. argentea* can be dried and preserved against season in India. This study is designed to evaluate the effects of organic and inorganic fertilizers on the growth of *Celosia argentea*.

**2. Materials and Methods**

The experiment was carried out at the experimental site of the Department of Plant Science, Ekiti State University Ado- Ekiti Nigeria (7040’N and 5015'E). Ado- Ekiti is in the rainforest zone of south- western Nigeria. The experiment was carried out from October, 2014 to March, 2015. Seeds of *Celosia argentea* were collected from Ikoga market, Badagry Lagos State. Cultivated soil was obtained at 10cm depth on campus, air dried for a week and sieved through a 5mm mesh. Equal amount of soil (4.8kg) was weighed with weighing balance into planting pots. Rooting analysis was carried out and the soil was sandy clay loam with soil organic matter content of 7.54%, 0.85% N, 16.21 mgkg-1 P, and 2150mgKg-1 K with a pH of 7.54. The treatments included two organic fertilizers (cow dung and poultry manure) obtained from Teaching and Research Farm, Faculty of Agricultural Science in Ekiti State University, Ado- Ekiti. Inorganic fertilizers (NPK 20, 15, 15) and Urea were obtained from Agricultural Development Project (ADP), Ado- Ekiti. NPK and Urea (200kgha-1) and 6t ha-1of cow dung and poultry manure were used. The poultry manure was analysed to have 2.50% N, 5.13mgkg-1P, 5856.64mgkg-1K and pH of 7.52. Likewise, the cowdung was analysed to have 2.19% N, 4.27mgkg-1 P, 8366.53 mgkg-1 K with pH of 8.20. The organic fertilizers were mixed with the soil two weeks before transplanting while the inorganic fertilizers were applied into the soil two weeks after transplanting of the seedlings using the ring method. The seedlings have earlier stayed in the nursery for three weeks.

The pot experiments were laid down in Completely Randomized Design with the treatments replicated four times. A control experiment without any fertilizer was also replicated four times. The parameters assessed were weekly heights, leaf area, number of leaves at harvest, stem girth, relative growth rate, number of fruits and biomass. The data collected from the experiments were subjected to statistics using Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used to separate the means.

**3. Results**

The effects of organic and inorganic fertilizers on the weekly height (cm) of *C. argentea* areshown in Table 1. It was revealed that the height of *C. argentea* increased weekly in all the treatments. *C. argentea* heights obtained in cowdung manure was the highest at 6weeks after transplanting (49.87cm) which was similar to those of poultry (47.44cm). The control experiment gave the least growth (37.22cm).

Statistical analysis (ANOVA, P< 0.05) revealed that no significant differences were observed in the initial heights of *C. argentea* when the treatments were compared to the control. At six weeks after transplanting (6WAT), no significant differences were observed in the heights of C*. argentea* treated with NPK, urea and those of control experiment. No significant differences were observed in poultry manure and cowdung fertilizers treated seedlings but were significantly different from the control, urea and NPK fertilizers.

Table 1. Effects of organic and inorganic fertilizer on the weekly heights (cm) of *Celosia argentea*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment | Initial height | 2WAT | 3WAT | 4WAT | 5WAT | 6WAT |
| Control | 1.90a | 3.16a | 12.25a | 19.97b | 32.35b | 37.22b |
| PM | 1.83a | 2.00c | 7.05a | 17.43b | 43.73a | 47.44a |
| CWD | 1.78a | 2.66b | 10.05a | 25.10a | 35.98b | 49.87a |
| NPK | 1.71a | 3.10a | 8.77a | 20.60b | 28.35c | 33.37b |
| Urea | 1.24a | 2.13b | 7.08a | 13.95c | 24.09c | 34.19b |

Mean followed by the same letter within column are not significantly different at (P<0.05).

The effects of organic and inorganic fertilizers on the mean number of leaves at harvest of *C*. *argentea* are shown in Table 2. The mean number of leaves at harvest (6WAT) in the control experiment was 22.00, poultry manure (51.63), cowdung (49.88), NPK (60.75) and urea (62.50). Statistical analysis revealed that significant differences were observed in the number of leaves in the treatments from 2WAT to 6WAT compared to the control experiment. No significant differences were observed in the initial number of leaves of *C. argentea* treated seedlings compared to the control experiment.

The effect of organic and inorganic fertilizers on the leaf area, number of spikes and green leaves at harvest of *C. argentea* are shown in Table 3. At 6WAT, the mean number of green leaves was 22.00 in the control experiment. Those of poultry manure treated seedlings were 51.63, cowdung (47.00), NPK (60.00) and urea (63.75). NPK fertilizer produced the highest number of spikes (17.00) and leaf area (72.63 cm2). These were similar to the other treatments asides the control experiment that had the least leaf area (35.33 cm 2) and spikes (4.50). Statistical analysis revealed that significant differences abound in the three variants compared to the control experiments.

The effects of organic and inorganic fertilizers on the stem girth and relative growth rate are shown in Table 4. NPK fertilizer produced the highest stem girth (15.75cm). The relative growth rate of poultry manure, cowdung and urea were similar. Control experiment has the least in the two parameters assessed. Significant differences were observed in the stem girth of the treated plants compared to the control experiment. The relative growth rate of the treated plants showed no significant difference from those of the control experiment.

The effects of organic and inorganic fertilizer on the biomass of *C. argentea* are shown in Table 5. It was revealed that the control experiment had the lowest fresh and dry shoot biomass (1.99g and 10.34g) respectively. Poultry manure treated plants had the highest fresh and dry root and shoot biomass with 4.71g and 2.21g respectively. Dry root and shoot biomass for poultry manure recorded the highest value with 26.55g and 6.63g respectively. Statistical analysis revealed that the fresh root biomass of the treated vegetables showed no significant difference from the control experiment. Dry root and shoot weights with fresh shoot weights of the treated vegetables showed significant differences from the control experiment.

Table 2. Effects of organic and inorganic fertilizer on the number of leaves at harvest of *Celosia argentea.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment | Initial number of leaves | 2WAT | 3WAT | 4WAT | 5WAT | 6WAT |
| Control | 5.38a | 9.75b | 16.75c | 21.88c | 30.13c | 22.00c |
| PM | 5.50a | 7.50c | 18.75b | 40.63b | 45.38b | 51.63b |
| CWD | 5.50a | 6.13c | 11.83d | 26.88c | 45.50b | 49.88b |
| NPK | 5.13a | 11.25a | 21.25a | 54.38a | 61.88a | 60.75a |
| Urea | 5.25a | 11.00a | 21.50a | 43.63b | 45.38b | 62.50a |

Mean followed by the same letter within column are not significantly different at (P<0.05)

Table 3. Effects of organic and inorganic fertilizer on the number of green leaves at harvest, leaf area (cm2) and number of spikes at harvest of *Celosia argentea.*

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | Number of green leaves at at harvest | Number of Spikes | Leaf area (cm2) |
| Control | 22.00c | 4.50c | 35.33d |
| PM | 51.63b | 12.50b | 61.39b |
| CWD | 47.00b | 10.25b | 53.61c |
| NPK | 60.00a | 17.00a | 72.63a |
| Urea | 63.75a | 12.38b | 62.94b |

Mean followed by the same letter within column are not significantly different at (P<0.05).

Table 4. Effects of organic and inorganic fertilizer on the stem girth and relative growth rate of *Celosia argentea.*

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | Stem girth (cm) |  | Relative growth rate |
| Control | 13.63c |  | 0.32a |
| PM | 15.50ab |  | 0.37a |
| CWD | 14.63b |  | 0.37a |
| NPK | 15.75a |  | 0.33a |
| Urea | 15.50ab |  | 0.37a |

Mean followed by the same letter within column are not significantly different at (P<0.05).

Table 5. Effects of organic and inorganic fertilizer on the biomass of *Celosia argentea*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment | Fresh root biomass | Freshshoot biomass | Dry root biomass | Dry root biomass |
| Control | 1.99a | 10.34b | 0.52c | 4.64c |
| PM | 4.71a | 26.52a | 2.21a | 6.63a |
| CWD | 3.76a | 24.82a | 1.12b | 5.79a |
| NPK | 4.11a | 24.82a | 1.10b | 6.27a |
| Urea | 4.27a | 24.47a | 1.56a | 6.16ab |

Mean followed by the same letter within column are not significantly different at (P<0.05).

**4. Discussion**

The highest growth in height of *C. argentea* occurred in organic manure cow dung which was similar to that of poultry manure. This might be as a result of the highest release of nitrogen and phosphorus from the organic fertilizer. Yinda and Adeoye (1994) and Adediran *et al*. (1999) had earlier reported that organic fertilization produce better yields of crops that keep longer and more nutritious than inorganic fertilizers. Wu *et* *al*. (2005) noted that bio-fertilizers such as organic manures has been identified as an alternative to chemical fertilizer to increase soil productivity and crop production in suitable farming. The increase in the plant height might be due to the improved soil fertility and soil water holding capacity. This corroborated the earlier assertions of Fallah *et al*. (2007) who noted that increase in plant height can be improved by improved soil fertility.

Though Urea fertilizer produced the highest number of leaves of *C. argentea*, this was similar to poultry manure treated plants. The work corroborated the earlier assertions of Shippers (2000) who noted that poultry and cattle manure significantly increase the green leaf of *C. argentea*. Akinfasoye *et al*. (2008) reported that maize stover, poultry manure compost and spacing, single and combined influence the growth and development of *Celosia.* The highest number of leaves recorded in urea fertilizer in this study might be as a result of it being pure nitrogen. This might led to the formation of more buds and increase in the number of leaves for photosynthesis and conserve energy. This corroborated the study of Zhang *et al.* (2010) who noted that nitrogen generally stimulates vegetative growth. Olaniyi and Ojetayo (2012) and Olaniyi *et al*. (2008) reported that *Celosia* plants increased in growth with increasing rate of nitrogen fertilizer and vegetative cropping system requires a greater degree of management. They noted that nitrogen increases the cell size and cellular number resulting from cell division and expansion that leads to increased stem girth, number of leaves and other vegetative parts of the plants.

NPK fertilizer produced the highest stem girth in *C. argentea*. This observation is supported by the work of Aliyu and Olanrewaju (1996) who noted that the beneficial effects of Nitrogen, Phosphorus and Potassium could be seen in the increase of stem girth of *Capsicum annum* and thus interpreted as accumulative growth.

**5. Conclusion**

Inorganic fertilizers might have adverse effects on the environment causing soil burn and pollution. It is costly and needs expertise for its application. Considering the availability and abundance of poultry manure and cowdung that are cheaper and environmental friendly, often referred to as farmers waste and does not need expert for their application.It is hereby recommended that poultry manure and cowdung might be a good option for the cultivation of *C. argentea*. Also, the vegetables produced from the organic fertilizers will be safer for human consumption.

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