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Morphological Characteristics of *Celosia argentea* As Influenced by Different Rates of Poultry Manure and Spacing In Northern Guinea Savana

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Abstract

A field experiment was conducted to find the response of Celosia Argentea L (Lagos Spinach) to varying doses of poultry manure and spacing at the Ahmadu Bello University Farms, Shika, Zaria. Spacing was done at 15x15cm, 20x20 cm, 25x25 cm and poultry manure applied at the rate of 0, 3, 5 and 7 t/ha arranged in a split-plot design and replicated three times. All agronomic practices were done manually without use of herbicides. Data were collected across two growing seasons and were subjected to analysis of variance (ANOVA) and means separated by Duncan Multiple range test (DMRT). Plant height, leaf yield, number of branches, stem girth, total yield and dry matter yield all significantly ($p<0.05$) increased with increase in manurial rate compared with control. Plant spacing had significant effect on number of branches and dry matter yield but had no significant ($p<0.05$) effect on stem girth and plant height. Combined effects of spacing and manure were significant for height, number of leaves and total yield. Highest dry matter and total yield was produced from the plot 20x20 cm and 5t/ha. In view of the cost of organic farming input and the concomitant produce from such farming, cropping Celosia argentea at 20x20cm and 5t/ha poultry manure appeared to be suitable for the study area.

Keywords: Vegetables, Plant Geometry, Organic Farming, Biofertilizer

Introduction

The plant specie *Celosia argentea* is a member of the genus *Celosia* and of the family *Amaranthacea*. The plant is known worldwide either as an ornamental plant or for food. The plant is widely distributed in West Africa from Sierra Leone to Nigeria and known in the Eastern part of Africa (Somalia, Kenya, Uganda). The plant has a worldwide traditional use. In India and other parts of Asia, C. argentea is used for the treatment of gynecological disorder (Wlart, 2000), blood diseases (Kirtikar and Basu, 1935). in China, C. argentea is employed as fertility regulating agent (Kong et al, 1986) and treatment of profuse internal bleeding in the Americas (Ticktin and Dalle, 2006).

The wild form of Celosia (C. trigyna) is a potherb throughout the savanna area of tropical Africa. In Africa, C. argentea is planted as a vegetable and commonly found intercropped in traditional Africa farms (Rehm and Espig, 1991). The leaves and young shoots are cooked and used in stews or soup and are rich in protein, calcium, phosphorus and iron (Akanbi *et al*, 2007).

Celosia requires a well-drained soil with a slight acidity pH 6.0 to 6.5 (Cull *et al.*, 1999). In indigenous Nigerian farms, yield of Celosia is reportedly (Schippers, 2000) low ranging between 1.6-2.8 kg/m^2 (Tindall 1984). Higher yields (6kg/m^2) have been reported (Olufolaji and Ayodele, 1988). Low plant density and poor physico-chemical properties and therefore, low fertility are inherent factors of low yields. To reverse these trends, increased plant population density and use of fertilizers would undoubtedly contribute to higher yields.

The use of inorganic fertilizers such as NPK, Urea, and other nitrogenous fertilizers to increase crop yields are well documented. Importation of these inorganic fertilizers is not only laborious, but also very expensive especially in the face of prevailing Nigerian economy.

Continuous and intensive use of inorganic fertilizers has been linked to influence nutrient imbalances, nitrate pollution, increased soil acidity (Sobulo, 2000; Akanbi 2002; Babajide *et al* 2008). The fear of soil and water pollution because of large-scale use of these fertilizers has prompted the clamour for the use of organic fertilizers including poultry manure to replace the inorganic fertilizers. Organic manure such as poultry manure helps build better and lasting organic matter in the soil, supporting an abundance of various invertebrates and other soil fauna leading to higher fertility status of such soil (Hole et al 2005, Herencia et al, 2007). Biofertilizers such as poultry manure have been identified as alternative to chemical fertilizers for increase in crop production (Wu et al, 2007).

Produce from organic farming have been reported (Yinda and Adeoye, 1994, Adediran *et al*, 1999) to keep longer and retain more nutrients than those from inorganic fertilized farms. Agro industrial and organic wastes such as poultry manure can pose environmental hazard if not converted to another use (Ayeni, 2010). Such use include economic and agricultural (organic farming) uses. There is dearth of information on production of Celosia argentea in Northern guinea savanna. This work studied the effects of different rates of poultry manure and spacing on production of Celosia argentea in Northern guinea savanna across growing seasons of 2014 and 2015.

Materials and Methods

Field studies were carried out at the Teaching and Research plots of Department of Vocational and Technical Education located within Ahmadu Bello University farms, Shika. Shika is located on longitude 11^0 12' N and latitude 7^0 32' E. Rainy season is from May to October with annual rainfall of 720mm.

Land clearing and preparations were done manually following the usual farmer's method with the aid of simple farm implements: hoes, cutlass. Selected physico-chemical analyses of the soil were carried out during soil preparation. The pre-cropping soil samples were analyzed for soil chemical properties. Soil $pH_{(H2O)}$ was determined using digital pH meter in soil:water 1:2 (w/v). Sand, silt and clay contents were determined by Bouyocous method. The major plant nutrients (N, P, K, Ca and Mg) were also determined for both the soil and poultry manure following the usual analytical method. Nitrogen was determined by mico Kjedhal method. Phosphorus was determined by Bray1 method and exchangeable cations by ammonium acetate (pH7).

Experimental design and treatment: The trial was laid out in split plot design with 3 spacing and four manure rate (0, 3, 4 and 7 T ha^{-1}) giving a total of 12 treatments. Plant spacing was the main plot while poultry manure rate was sub plots. The subplots size was $3m^2$ replicated three times. The main plot was separated by pathway 1 m wide. Seeds of Celosia argentea locally obtained from farmers shops in Zaria were planted after sterilization. This was done by rinsing the seeds briefly in 95% ethanol for about 12 seconds and then shake for 3 minutes in 3% Hydrogen peroxide. The seeds were then vigorously rinsed with equal aliquots of sterile water. Seeds were sown by drilling method at spacing of 15x15cm, 20x20cm and 25x25cm.

Well cured poultry manure was applied by spreading ten days before sowing. Four doses of poultry manure at the rate of 0, 3, 5 and 7t ha^{-1} were applied. The poultry manure was lightly worked into the soil to a depth of 10cm with the aid of hoes. Emerged seedlings were thinned to one plant per stand at 3 weeks after sowing (WAS).

Agronomic Practices: Weeding of the plots was done manually by hoeing. As the incidence of pest was minimal, there was no use of pesticides or herbicides.

Data collection: At 5 WAS five plants were randomly sampled from each plot. Harvesting was done by cutting the plant 10cm above the soil surface level while subsequent cutting of branches (off shoot) was done every fortnight. Four cuttings were done before the trial was terminated due to the emergence of inflorescence dry matter. Yield was estimated by uprooting 5 samples randomly per plot and cut into root and shoots. The samples were dried at 70^{o}C for three days until constant weight was attained. The dried samples were weighed and recorded

Data analysis: All data collected were analysed combined for the two growing periods. The data collected were subjected to analysis of variance and the means compared by Duncan's multiples range test as described by Steel and Torrie (1980)

Results

Physico chemical analysis of the pre cropping soil samples revealed that the soil at the trial site was moderately acidic pH 5.8 and texturally sandy loam (Table 1). Shika soils are classified as ferruginous tropical soils developed over schist, gneiss and quartzite (Klinkenberg and Higgins, 1968). The contents of major plant nutrients of the poultry manure (N,P,K, Ca, and Mg) were within the range documented by FAO (2005) for West African region.

Table 1 Physico-Chemical Properties of the soil and Poultry Manure

Property	Soil	Poultry Manure
pH	5.8	6.2
Organic carbon (g/kg)	1.24	-
Sand (g/kg)	601	-
Silt (g/kg)	268	-
Clay(g/kg)	131	-
N %	0.05	1.87
P %	0.84	1.36
K (g/kg)	0.56	2.11
Ca (g/kg)	2.12	8.72
Mg(g/kg)	0.38	0.66

Growth of Celosia (Table 2) increased with increasing rate of poultry applications. Amendment of the soil by poultry manure significantly ($P<0.5$) increased growth parameters of *Celosia argentea*. Parameters such as plant height, stem circumference, and leaf area per plant all increased with increasing rates of poultry manure in comparison with control (0t/ha poultry manure). Plant height increased from 29.26cm (control plot) to about 72.42cm, stem growth from 1.42cm to 3.67cm.

The highest plant height (72.45cm), highest number of leaves (26.3) and highest number of shoot (20.1) per plant including highest leaf area and dry matter are all found in the plot amended with 7T/ha (P7) poultry manure. However, no significant ($P>0.05$) difference was obtained between the effect of 5t ha^{-1} (P5) and 7t ha^{-1} of poultry manure application on the growth of celosia. The effect of the spacing revealed 20cmx20cm (S2) spacing was significantly different from 15x15cm (S1) but not so for 25cmx25cm (S3).

Table 2 Simple effect of rate of poultry manure and spacing on growth of Celosia

Treatments	Plant height (cm)	Stem girth (cm)	No of leaves/plant	No of shoot plant	Leaf area/plot	Dry matter (g/plant)
Poultry manure rate t/ha						
0	29.26 [a]	1.42 [a]	14.6[a]	4.1	932.6[a]	2.75[a]
3	44.72b	2.02a	22.4ab	15.4	4185.3b	5.72[b]
5	68.66[bc]	2.76[b]	24.7[ab]	17.2	5802.5[c]	9.16[c]
7	72.42[c]	3.67 [bc]	26.3 [ab]	20.1	6671.4 [cd]	9.86[c]
Sowing dist.						
S1	52.62[a]	2.09[a]	21.1[a]	8.8[a]	3103.3a	6.88
S2	56.28[a]	2.36[a]	25.1[a]	15.7[b]	5793.7[b]	9.74
S3	58.44[a]	2.52[a]	25.8[a]	18.6b[c]	5861.6[bc]	8.40

Means followed by same letter within column are not statistically different at 5% level of significance
S1= 15x15cm, S2= 20x20cm, S3= 25x25cm

The effect of interaction between spacing and manure rate on growth of celosia is found on Table 3. Plant stem growth ranged from 0.78cm to 2.47cm at S1xP0 (T ha^{-1}) to S1xP7 and to 3.05cm at S3xP7. The combined interaction of spacing and poultry manure rate at 25cmx25cmx7t ha^{-1} consistently produced significantly (P<0.05) higher leaf area, plant height and number of leaves per plant, being 6347.2cm^2, 28 and 71.16cm respectively. The largest leaf area per plant 6347.2cm^2 was obtained with treatment S3xP7 but was not significantly (P>0.05) different from that produced by treatment S2xP7. Thus the leaf area at higher dose of poultry manure (7T/ha) and 25cmx25cm spacing was not significantly different at p<0.05.

Table 3 Effects of interaction of rate of poultry manure and sowing space on morphological properties of Celosia

	Treatment	Stem circumference (cm)	Plant height	No of leaves/plant	No of branches/plant	Leaf area (cm2)
S1 vs	P0	0.78	27.86a	14	4a	588.1[a]
	P3	1.42	41.63b	19	8ab	2779.6[b]
	P5	2.10	64.81c	21	12b	4692.8[cd]
	P7	2.47	67.66c	27	14b	4719.3[c]
S2 vs	P0	1.76	29.63a	14	5a	1216.4[ab]
	P3	1.95	45.31b	21	9ab	3265.1[ab]
	P5	2.31	68.55d	27	17c	5397.7[dc]
	P7	2.48	67.12d	29	24d	6106.4[d]
S3 vs	P0	1.52	32.74a	17	7a	982.3 [ab]
	P3	2.09	44.16b	24	14b	4370.2[c]
	P5	2.68	57.58bc	27	21d	5916.1[dc]
	P7	3.05	71.16d	28	21d	6347.2[d]

Means followed by same letter within column are not statistically different at 5% level of significance
S1= 15x15cm, S2= 20x20cm, S3= 25x25cm

The response of Celosia shoot yield to interactive effect of poultry manure and spacing is shown in Table 4. Cumulative plant shoot yield significantly (P<0.05) increased with increasing rate of poultry manure from 6.88t/ha (Po) to 36.92t/ha (P7). Cumulative above ground (shoot) yield is not significantly (P>0.05) affected by spacing, however spacing at S3 produces highest cumulative above ground shoot.

Table 4 Combined effect of rate of poultry manure and sowing space on yields of Celosia

	Above ground (shoot) yield/ha				
Treatment	**1**	**2**	**3**	**4**	**Cumulative**
Manure (t/ha)					
P0	1.56	1.86	2.37	1.09	6.88b
P3	3.4	3.91	4.12	2.20	13.63b
P5	6.7	8.44	9.72	5.81	30.67a
P7	6.9	12.77	10.14	7.11	36.92a
Spacing					
S1	3.78	6.77	4.78	3.41	24.74b
S2	6.72	7.45	11.43	4.12	29.72[a]
S3	4.22	6.01	7.44	3.10	26.77[b]
Spacing X Rate					
S1 x P0	1.1	1.3	0.9	0.95	4.25[a]
S1 x P3	2.9	3.5	4.2	3.1	13.70[c]
S1 x P5	4.4	9.3	5.5	3.6	22.8 [bc]
S1 x P7	6.4	12.3	5.2	3.4	27.33 [c]
S2 x P0	1.7	2.85	1.2	1.11	5.86[a]
S2 x P3	4.3	6.25	3.77	3.00	17.32[b]
S2 x P5	9.62	12.77	6.88	3.60	32.88[c]
S2 x P7	7.22	11.06	7.50	6.06	31.84b[c]
S3 x P0	1.28	2.16	0.9	0.78	5.12[a]
S3 x P3	3.7	8.20	4.3	2.11	18.31[b]
S3 x P5	6.3	12.7	7.2	4.3	30.46[bc]
S3 x P7	7.4	14.3	6.3	3.4	31.55[c]

Means followed by same letter within column are not statistically different at 5% level of significance
S1= 15x15cm, S2= 20x20cm, S3= 25x25cm

Discussion

The Physico-Chemical analysis of the soil showed that the soils are moderately acidic, with low concentration of plant nutrients and textually a sandy loam. This is in agreement with earlier works of Tanimu *et al*, (2013) and Tarfa *et al*, (2003) who all obtained similar range of nutrients in savanna soils. Increase in growth of celosia as a result of application of poultry manure is expected in that manure contains considerate amount of available nutrient: N, Mg, K and P for plant use. These nutrients help in building of chlorophyll necessary for continued plant growth and development. Application of manure increases the organic matter content of the soil which in turn impact positively on the physico-chemical properties of such soil. The increased growth of celosia as rate of applied manure increases is also expected. Increased rate of application of manure produced more nutrients and hence more positive result in the growth of the crop. This result is in agreement with Atanda and Olaniyi (2016) and Kadayifli *et al* who all reported that increasing nitrogenous nutrients generally increase growth parameters and nutrient uptake of plants.

The observed higher plant growth and yield at wider spacing was due to availability of more conducive micro-climate for the crop. At wider spacing, competition for nutrient by plant is reduced and therefore more nutrients are made available per plant. Similar findings had been reported by Shiyam and Binang (2011). Interaction effect of poultry rate application and spacing on vegetative growth of the plants was obvious. At wider space and higher rate of manure such as 20 x 20 x 5 t/ha the growth properties and yield were significantly higher than at lower levels. This greater effect was due to enhanced fertility in crop ecology

Conclusion

Different rates of poultry manure and spacing had significant effect on growth and yield of celosia. Growth and yield of celosia increased with increasing rate of poultry manure. Combination of 20 x 20 cm spacing with 5 t/ha poultry manure produced the best yield, even though interaction at 25 x 25cm x 7t ha^{-1} manure produced higher yield but not significantly better. In view of cost of farming inputs, and other economic reasons, application of poultry manure at 5 t/ha at 20 x 20 cm spacing appeared to be optimum for growth of celosia argentea in the study area.

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