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EFFECTS OF NITROGEN ON GROWTH, YIELD, NUTRIENT UPTAKE AND QUALITY OF CELOSIA (*Celosia argentea*) VARIETIES.

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A pot trial was conducted at the Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso during 2007 planting season to examine the effect of different rates of nitrogen (N) fertilizer on growth, shoot yield, nutrient uptake and quality of celosia varieties. Four levels of N fertilizer (0, 30, 45 and 60 kg N ha^{-1}) applied as urea and four celosia varieties (green broad leaf, ornamental, red broad leaf and green narrow leaf) were laid out in a factorial experiment and fitted into a randomized complete design with three replications. The plant height, number of leaves and fresh and dry shoot yields were significantly affected by the applied N fertilizer with the optimum values obtained at 45 kg N ha^{-1} for all the tested varieties, except ornamental variety which had most leaves at 60 kg N ha^{-1}. The quantity of essential nutrients (Fe, Mg), protein and vitamins significantly increased as N fertilizer rates increased among all varieties. The highest nutritional values were recorded at 45 kg N ha^{-1} which declined with further increase in N. The varietals effect significantly influenced growth parameters, nutrient uptake, shoot yield and quality of celosia. Except for growth parameters, green broad leaf recorded the highest values for all the parameters examined in this study. In summary, the yield and nutritional quality of celosia in Guinea Savanna zone of Nigeria can be significantly improved with application of N fertilizer at 45 kg N ha,$^{-1}$ and green broad leaf is the best variety for this agro ecological zone.

Key words: *Celosia argentea,* N rates, shoot yield, nutrient uptake, and nutritional values.

INTRODUCTION

The wide diversity of C*elosia argentea* in Tropical Africa points to an origin of the crop in this region It is one of the leading leaf vegetables in South Western Nigeria where it is known as 'soko yokoto' in the Yoruba language. There are three major types of *celosia argentea* cutivated as vegetable in Nigeria and Benin. Green broad leaf cultivars called 'soko green', red broad leaf cultivars with anthocyanin pigmentation of the leaf blades and part of the stem called 'soko pupa' and cultivars with deep green narrow leaves with hard texture and early flowering. The ornamental forms of *Celosia argentea* with fascinated inflorescences (cock's comb) probably originated from India. These are widely grown as an ornamental in the Tropics and Sub-Tropics, and in temperate region during summer (Grubben and Denton, 2004)

Celosia is primarily used as a leafy vegetable. The leaves and tender stems are cooked into soups, sauces or stews with various ingredients including other vegetables such as onions, hot pepper and tomato and with meat, fish and palm oil. The soup is consumed with the staple food of rice, maize, cassava or yam. The seed could be processed into food items, supplements and additives. It is an important source of protein, minerals and vitamins, especially in areas where animal protein sources are scarce. The composition of *Celosia argentea* per 100 g edible portion is: 83.8 g water; 185 kj energy; 4.7 g protein; 0.7 g fat; 7.3 g carbohydrate; 1.8 g fibre ; 260 mg Ca; 43 mg P and 7.8 mg Fe, (Grubben and Denton, 2004).

The composition of *Celosia argentea* is strongly influenced by environmental factors i.e soil fertility, fertilizer application and age of the plant at harvest (Grubben and Denton, 2004). A high level of organic material in the soil is required for the green form. Lucas (1988) recommended application of 50-100 kg N, 20-60 kg P_2O_5 and 40-60 kg K_2O ha^{-1} after two weeks of planting. Babatola and Olaniyi (1999) revealed that 120 kg and 160 kg N ha^{-1}ave the best yield of *Amaranthus caudatus*. Vegetable cropping systems require a greater degree of management and utilize a large N input than most agronomic cropping systems. The objective of this research is to determine the optimum level of N fertilizer required for maximum growth, shoot yield, nutritional values and quality of *Celosia argentea* varieties.

Materials and Methods

A pot experiment was conducted at the Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso. Ogbomoso lies between latitude 8^0 10'N and longitude 4^0 10'E with mean annual rainfall of between 1,150 mm and 1,250 mm (Olaniyi, 2006).

The experimental plot was cleared and levelled. The polythene bags were laid out into three replications with each replication containing 16 bags making a total of 48 polythene bags. Each bag was spaced at a distance of 1.0 m from one another to ease movement during cultural operations. Each bag was filled with 40 kg of air dried and sieved top soil and perforated at the bottom to facilitate drainage of excess water from the bag. The physico-chemical properties of the soil used was determined (IITA, 1989). It contained 6.3 pH (H_2O), 0.051 mg/kg organic carbon, 0.09 mg/kg total N, 5.65mg/kg available P, 0.12 c mol/kg exchangeable K, 0.16 c mol/kg exchangeable Na, 7.51c mol/kg exchangeable Ca, 0.78c mol/kg exchangeable Mg, 0.04 c mol/kg exchangeable acidity, 8.8 c mol/kg ECEC, 85% sand, 5% silt, 10% clay and textural class is sandy loam. The treatments applied were four levels of N fertilizer applied as urea, namely: 0, 30, 45 and 60 kg N ha^{-1} and four varieties of *Celosia argentea* seeds which are green broad leaf, ornamental, red broad leaf and green narrow leaf celosia. The 16 treatment combinations were assigned into a factorial experiment and fitted into a complete randomized design with three replications. The pots were irrigated for two days before sowing. Six seeds of celosia varieties were sown in the middle of each bag and slightly irrigated. The seeds were slightly mulched after sowing to protect them from direct solar radiation and excessive heat. This also made wetting easy as it prevents displacement of seeds and exposure of the roots of the emerging seedlings during watering.

After germination, the seedlings were thinned to one plant per bag. Weeding was carried out manually at 3 and 6 weeks after sowing. Fertilizer was applied three weeks after sowing. Pests were controlled by spraying the plants with Marshal (Lambda-cyhalothrin 2.5 EC) at 5 ml per 10 litres of water at two weeks intervals.The growth and yield data collected included plant height, number of leaves, fresh and dry matter yields. At harvesting, the shoot fresh yield per plant as well as the dry matter yield after drying was determined.

The plant samples were collected and dried in an oven at 65^0C till constant weight was obtained. The dried plant samples were grounded with a Wiley mill and passed through a 0.5mm sieve to access the nutrient elements status in plants. Total N was determined by the macro-kjeldahl procedure as described by I.I.T.A (1982). The P and K contents of the plants were determined by wet digestion with a mixture of sulphric, and perchloric acids. Phosphorus concentration was determined by the vanadomolybdate yellow colorimetry method. Digested samples were diluted and used to determine the concentrations of K using an atomic absorption spectrophotometer. Concentrations of nutrient were expressed on the basis of percentage dry plant material.

All the data collected were subjected to analysis of variance (ANOVA) using the SAS – GLM procedure (SAS, 1989). The means were separated using the least significant difference at 5%.

Results

Growth parameters and shoot yields

The data on plant height, number of leaves, fresh and dry shoot yields of celosia as affected by N rates is given in Table 1. There is significant difference in the growth parameters and shoot yields among the varieties. Narrow green leaf has the highest plant height but most leaves were obtained from ornamental, while green broad leaf had the least values for these growth parameters. Also, the highest fresh and dry shoot yields were recorded for green broad leaf, while narrow green leaf gave the least values. Likewise, different N rates had significant effect on the plant height, number of leaves, and fresh and dry shoot yields of celosia. These growth and yield attributes increased with increasing rate of N up to 45 kgN $ha^{-1,}$ and declined thereafter irrespective of variety. The interactive effect of nitrogen and variety significantly influenced the number of leaves of celosia varieties.

Nutrient uptake

The nutrient uptake of celosia plants was significantly improved by the applied N (Table 2). The green broad leaf plants absorbed more of the nutrient elements than the plants of other varieties. There was a significant varietals effect on the nutrients absorption of celosia plants. The N, P and K contents of plants increased with increasing application of N fertilizer. The optimum nutrient uptake was obtained at 30 kg N ha^{-1}which declined at 40 kg N ha^{-1}. The interaction of nitrogen and variety significantly influenced the nutrient uptake of celosia plants.

Nutritional quality

The proximate analysis of celosia shoot revealed that the applied N fertilizer had significant effect on the mineral compositions and nutritional qualities of celosia varieties (Table 3). The highest nutritional values were recorded at 45 kg N ha^{-1} , while the control gave the least values. The mineral compositions and nutritional qualities of celosia shoot were significantly influenced by the various varieties. The highest values were obtained from green broad leaf, except for N and protein which were found more in green narrow leaf and ornamental. All the nutritional attributes examined were significantly improved by the nitrogen and variety interaction.

Table 1: Effects of N levels on the growth and shoot yield of celosia varieties at 9 weeks after sowing.

Varieties	Plant height (cm)					Number of leaves					Fresh shoot weight (g)					Dry shoot weight (g)				
	N applied (kg ha^{-1})					N applied (kg ha^{-1})					N applied (kg ha^{-1})					N applied (kg ha^{-1})				
	0	30	45	60	Mean	0	30	45	60	Mean	0	30	45	60	Mean	0	30	45	60	Mean
Green broad leaf	37.67	34.64	42.00	40.56	38.72	37.34	39.55	43.33	34.44	38.67	69.0	97.7	98.3	91.7	97.2	8.67	12.67	16.67	10.33	12.09
Ornamental	33.00	39.69	47.35	55.00	43.01	110.33	127.35	190.35	241.70	267.43	74.0	73.0	85.0	81.0	78.3	6.33	6.67	8.67	6.33	7.0
Red broad leaf	41.42	51.79	54.44	47.44	48.77	43.35	48.33	51.55	44.00	46.81	45.7	56.0	81.0	68.0	74.1	6.33	6.67	8.33	6.67	7.0
Green narrow leaf	71.11	74.99	83.44	73.46	75.75	47.22	51.89	55.00	46.00	50.02	27.5	36.0	52.0	48.0	40.88	4.67	7.00	11.00	3.99	6.42
LSD (0.05) N					19.1					43.1					53.1					4.6
LSD (0.05) variety					19.1					43.1					53.1					4.6
LSD(0.05) varietyxN					NS					1857.6					NS					NS

NS=not significant

Table 2: Effects of N levels on the plant nutrient uptake of celosia varieties at 9 weeks after sowing.

Varieties	Nitrogen					Phosphorus					Potassium				
	N applied (kg ha^{-1})					N applied (kg ha^{-1})					N applied (kg ha^{-1})				
	0	30	45	60	Mean	0	30	45	60	Mean	0	30	45	60	Mean
Green broad leaf	77.48	164.92	248.00	155.62	161.51	7.20	11.40	19.00	10.85	12.11	5.46	7.98	11.50	7.75	8.17
Ornamental	54.88	87.78	159.72	46.89	87.31	3.50	5.88	10.56	2.79	5.68	2.80	4.41	7.92	2.25	4.34
Red broad leaf	49.40	63.40	106.25	73.80	73.21	4.56	5.20	7.00	7.00	5.94	3.40	4.00	5.50	8.80	5.43
Green narrow leaf	77.90	87.20	93.13	76.38	83.65	3.99	5.40	9.36	6.46	6.30	2.85	4.00	5.46	3.99	4.01
LSD (0.05) N					1.44					0.21					0.55
LSD (0.05) varieties					1.44					0.21					0.55
LSD (0.05) N X varieties					2.07					0.04					0.30

Table 3: Effects of N levels on the shoot nutritional values of celosia varieties at 9 weeks after sowing.

N level (kg ha^{-1})	Variety	%Ca	%Mg	%K	%P	%N	Fe (ppm)	%Protein	%Fat	%Fibre	mg/100g Vit.c
0	Green broad	0.68	0.30	0.21	0.27	2.98	96.02	18.65	1.07	14.45	17.16
30	Leaf	0.69	0.32	0.21	0.30	4.34	99.65	27.15	1.25	14.75	19.26
45		0.75	0.36	0.23	0.38	4.96	105.56	31.01	1.38	16.30	20.15
60		0.72	0.21	0.25	0.35	5.20	105.07	32.50	1.10	15.10	18.10
Mean		0.71	1.19	0.23	0.33	4.37	101.58	27.33	1.20	15.15	18.67
0	Ornamental	0.67	0.25	0.20	0.25	3.92	44.15	24.52	1.01	14.32	16.50
30		0.73	0.28	0.21	0.28	4.18	76.23	26.15	1.18	15.00	18.02
45		0.80	0.35	0.24	0.32	4.84	85.65	30.25	1.20	17.35	18.50
60		0.76	0.30	0.25	0.31	5.21	80.55	32.55	1.02	16.75	18.15
Mean		0.74	0.30	0.23	0.29	4.54	71.65	28.37	1.10	16.86	17.79
0	Red broad	0.58	0.32	0.16	0.24	2.60	67.02	16.28	1.24	14.25	16.25
30	Leaf	0.65	0.36	0.20	0.26	3.17	88.20	19.83	1.26	14.50	17.85
45		0.70	0.38	0.22	0.28	4.25	95.35	26.56	1.40	16.56	18.25
60		0.68	0.34	0.22	0.35	3.69	86.75	23.07	1.08	16.05	17.75
Mean		2.23	0.35	0.20	0.28	3.43	84.33	21.44	1.25	15.34	17.53
0	Green narrow	0.62	0.29	0.15	0.21	4.10	64.05	25.65	1.03	15.45	15.75
30	Leaf	0.69	0.35	0.20	0.27	4.36	69.55	27.25	1.14	16.52	16.50
45		0.70	0.39	0.21	0.36	5.50	82.60	31.55	1.17	17.56	18.05
60		0.69	0.25	0.21	0.34	4.20	77.16	25.15	1.15	17.18	17.75
Mean		17.75	0.32	0.19	0.30	4.54	73.34	27.40	1.12	16.68	17.01
LSD (0.05)											
Nitrogen(N)		0.03	0.05	0.02	0.16	1.44	2.06	0.20	0.12	0.17	0.56
Variety (V)		0.03	0.05	0.06	NS	1.44	2.06	0.20	0.12	0.16	0.56
VXN		0.04	0.05	0.07	NS	1.59	2.28	0.22	0.13	0.18	0.62

NS= not significant

DISCUSSION

All celosia plants exhibited uniform morphotype as they all increased in growth with increasing rate of N fertilizer. Previous studies carried out by Babatola and Olaniyi (1999) revealed that 120-160 kg N ha^{-1} through urea produced the best growth and yield of *Celosia argentea. The* significant increase in growth and yield attributes with increased N rate, agreed with the findings of Naidoo (2009), which may be attributed to increase in rate of photosynthesis as a result of increased leaf chlorophyll synthesis and nutrient efficiency of the vegetable plant.

According to Olaniyi *et al*., (2008) vegetable cropping system requires a greater degree of management and utilizes a large N input than most agronomic cropping systems, which suggests that increase in N rate increases cell size and cell number as a result of cell division and expansion leading to increased stem growth, number of leaves and other vegetative parts of the plant. The positive effect of applied N rates on both fresh and dry shoot yields was in agreement with the report of Olaniyi (2000), where NPK was effective in increasing final melon yield.

The increase in nutrient uptake, chemical compositions and nutritional qualities of celosia varieties with increasing N rate up to 45 kg N ha^{-1} confirmed the earlier work of Grubben (1977) who observed an increase in yield and chemical compositions of several tropical vegetables including an unspecified variety of *Celosia argentea* with increased N fertilizer application. Also total N, calcium, and magnesium content of vegetable increased with increased N fertilizer application (Jones *et al*, 1991). Lovelock *et al* (2007) reported N and P as an essential component of all enzymes and protein synthesis. Though green broad leaf had the highest mineral compositions and nutritive constituents, narrow broad leaf and red broad leaf had more protein and fat, respectively which is due to varietals composition and make up. Generally vegetables serve as an important source of nutrients in Nigerian diet because of low cost and availability.

CONCLUSION

Nitrogen fertilizer treatment significantly influenced the morphological and biochemical parameters of Celosia varieties. Number of leaves, plant height, fresh and dry weight of shoot, nutrient uptake and mineral compositions were improved with the applied N rates. Therefore, the optimum recommended rate for maximum performance of *Celosia agentea* in this ecological zone seems to be 45 kg N ha^{-1}. Green broad leaf variety gave best shoot yield and nutritional attributes, and therefore can be recommended for this zone.

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