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Effects of NPK (15:15:15) Fertilizer on Some Growth Indices of Pumpkin

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ABSTRACT

Effects of NPK (15:15:15) fertilizer on some growth indices of pumpkin, *Cucurbita moschata* (Duch. *ex* Lam.) Duch. *ex* Poir. were studied. Eight treatments viz; 0, 200, 250, 300, 350, 400, 450 and 500 kg of NPK fertilizer per hectare (kg ha^{-1}) were used in a Randomized Complete Block Design (RCBD) with four replicates. These treatments were applied once to two week-old seedlings of *C. moschata* using ring method. The effects of these treatments on Leaf Area (LA), stem diameter (STD) and number of leaves (NL) were monitored weekly while fresh weight and dry weight were determined after 6 weeks. Soil Organic Matter (OM), Organic Carbon (OC), ash content, pH and nutrient (N, P, K, Ca, Na and Mg) levels were also monitored at 0, 2 and 6 weeks. The study showed that NPK fertilizer increased the LA, STD, NL and nutrient (N, P, K, Ca, Na and Mg) contents of the soil. The highest leaf area, stem diameter, fresh weight and dry weight were obtained from NPK treatment at 300 kg ha^{-1} while 350 kg ha^{-1} rate gave the highest number of leaves. Two weeks after treatment, the concentrations of N, Ca, Mg, OM and OC content in the soil were highly increased by the 400 kg ha^{-1} treatment but the 500 kg ha^{-1} rate gave the highest concentrations of K and Na. The study after six weeks showed that 450 kg ha^{-1} rate gave the highest concentrations of Ca, Mg and K in the soil whereas 500 kg ha^{-1} rate gave the highest concentrations of P, Na and ash content. The 350 kg ha^{-1} gave the highest N, OM and OC content. At $p<0.05$, there were significant difference among treatments. The use of NPK fertilizer at an application range between 400 and 450 kg NPK ha^{-1} is therefore recommended for growing of *C. moschata* and improvement of the soil nutrients level.

Key words: NPK fertilizer, amended soil, *Cucurbita moschata*, organic matter, organic carbon

INTRODUCTION

C. moschata commonly known as musk pumpkin belongs to the family Cucurbitaceae and is native to Nigeria. Its flowers, young stems and ripe fruits are eaten as a vegetable (Grubben *et al.*, 2004). The leaves are also commonly used to prepare sweets as well as been used as fodder. The seeds are eaten whole, roasted or toasted and are ground into different stews. Achu *et al.* (2005) reported that the seeds of pumpkin have high oil and protein contents and their consumption in urban areas is also fairly common. It is cultivated for both the leaves and fruits while the leaves are important vegetables, the pulp of the fruit is eaten when cooked (Okoli, 1984; Ndukwu and Okoli, 1992). In Nigeria, cultural practices are still extensive and yield levels are low.

Fertilizers are sources of plant nutrients that can be added to the soil to supply its natural fertility (Abd El-Aziz, 2007). Profitable responses to NPK fertilization are mentioned by Conover and Poole (1990). Organic matter also has been reported to acts as a reservoir of plant nutrients especially N, P, K and micronutrients and also prevents leaching of nutrients. Karim *et al.* (1994) reported that due to poor management and intensive manipulation of soil, organic matter content is getting reduced day by day. Available data according to Karim *et al.* (1994) and Ali *et al.* (1997) showed that the fertility of most soils has deteriorated over the years. The reduction in the soil fertility level is responsible for stagnating and, in some cases, even declining crop yields (BARC, 1997; Cassman *et al.*, 1995). This was also supported by BARC (1999) that about 45% of net cultivable area of Bangladesh has less than 1% organic matter content. However, John *et al.* (2004) reported that inorganic fertilizers are the most important sources of Nitrogen (N) and adequate supply of N is associated with high photosynthetic activity, vigorous vegetative growth and a dark green colour of the leaves. Although, it has been mentioned by several researchers that the availability of nutrients influences plant growth and can determine community structure. However, there are species and community specific responses and adaptations that enable plants to cope with specific nutrient limitations. The use of chemical fertilizers as a supplemental source of nutrients has been on the increase but they are not applied in balanced proportions by most farmers. The study, therefore, seeks to determine the effects of rates of NPK fertilizer application on soil nutrient level and growth of pumpkin, *C. moschata*.

MATERIALS AND METHODS

The mature fruits of pumpkin, *C. moschata* used for this study were harvested from a subsistent farm in Abiriba, Abia State. The seeds were removed from the fruits, air dried and stored at room temperature. Soil samples were obtained from the upper soil surface layer (0-15 cm) using a 5 cm diameter soil auger. The soil samples were air dried for analysis to establish the initial soil chemical properties used for the experiment. About 5 g of the air-dry soil was taken in a glass beaker and 10 mL of distilled water was added. The contents were mixed thoroughly with a glass rod and allowed to stand for 30 min. The soil pH was measured using EQUIP-TRONICS Digital pH meter model EQ-610. The soil samples and poultry manure were digested on a labcon digester at 300°C in a mixture of hydrogen peroxide, sulphuric acid, selenium and salicylic acid (Okalebo *et al.*, 2002). The digests were analysed for total N, P, K, Na, Ca and Mg. The total N content in the digests were determined by Kjeldahl method, 10 mL of the digest solution was taken in the distillation flask, 20 mL of 40% NaOH was added and the NH_3 evolved was collected in a flask containing 4% H_3BO_3. Finally, the distillate was titrated against 0.1 N H_2SO_4. Total phosphorous was determined using the ascorbic acid blue colour procedure and the absorbance measured at 880 nm wavelength UV-spectrophotometer. The Ca, K and Mg contents in 1/20 dilution (sample/distilled water) soil digests were measured by reading their absorbance on a UNICAM 969 Atomic Absorption Spectrophotometer at 766.5, 422.7 and 285.2 nm, respectively. The sodium content in 1/20 diluted sample were determined by reading their absorbance at 248.3 nm (Okalebo *et al.*, 2002). For total organic carbon, two gram of soil was taken in a 500 mL Erlenmeyer flask, 10 mL of 1 N $K_2Cr_2O_7$ was added and the flask was swirled to mix the contents. Twenty milliliter of conc. H_2SO_4 was added to the soil suspension; flask was swirled again for 1 min and allowed to stand for 30 min. After this, 200 mL of water, 10 mL of H_3PO_4 and 1 mL of diphenylamine indicator were added and the contents were titrated against 0.5 N $FeSO_4.7H_2O$ until the colour changed from blue to red. The organic matter was obtained by multiplying total organic carbon values by a conversion

factor of 1.27 (AOAC, 1990). NPK (15:15:15) fertilizer was used as treatment. The treatments were 0, 200, 250, 300, 350, 400, 450 and 500 kg NPK ha^{-1}. The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments were applied once to two week-old seedlings of *C. moschata* using ring method. Each treatment was replicated four times. The plants were staked to avoid creeping on the ground. The soil chemical properties (N, P, K, Ca, Na and Mg) were assessed 2 and 6 weeks after planting following the method described above.

Measurement of plant material: The leaf area, stem diameter and number of leaves were measured weekly, while fresh weight and dry weight of *C. moschata* were measured 6 weeks after planting. The leaf area was determined by rapid leaf area estimation as described by Salau and Olasantan (2004) for pumpkin leaf. The stem diameter was determined by measuring the stem close to the ground with vernier caliper while the number of leaves was obtained by direct counting of the leaves. The fresh weights of *C. moschata* were obtained using Metler balance (Model PN 163) which were measured immediately after harvest to avoid water loss while the dry weight were obtained by drying the samples in a plant dryer (Baird and Tatlock, Greenfield England) at 80°C for 48 h to obtain a constant weight.

Statistical analysis: Statistical analyses of data obtained for plant parameters and soil samples were by Analysis of Variance (ANOVA) using the statistical package, SPSS 17.3. Means were compared using the 5% level of significance.

RESULTS AND DISCUSSION

Effect of NPK on some growth indices of *C. moschata*: The addition of NPK treatments to the soil increased the leaf area, stem diameter, number of leaves, fresh weight and dry weight of *C. moschata* and all NPK treatments had significantly broader leaf area, stem diameter, number of leaves (Table 1), fresh weight and dry weight (Table 2) than the control respectively. However, among treatments, 300 kg ha^{-1} showed the highest leaf area. The 300 kg ha^{-1} treatment consistently increased the stem diameter, fresh weight and dry weight of *C. moschata* while the

Table 1: Effect of NPK treatments on number of leaves, leaf area and stem diameter of *C. moschata*

Treatment	10 DAT			17 DAT			24 DAT			31 DAT		
(kg NPK ha^{-1})	NL	LA (cm^2)	STD (cm)	NL	LA (cm^2)	STD (cm)	NL	LA (cm^2)	STD (cm)	NL	LA (cm^2)	STD (cm)
0	6	29.75	0.395	7	35.5	0.468	8	43.25	0.610	8	47.00	0.513
200	5	59.75	0.478	6	161.5	0.743	15	224.50	1.035	21	229.50	1.025
250	8	117.25	0.800	12	187.5	0.960	18	200.25	1.100	19	204.50	1.115
300	8	152.50	0.843	13	265.75	1.063	19	271.50	1.245	23	277.75	1.273
350	8	119.00	0.723	12	197.00	0.953	19	239.00	1.095	25	237.75	1.015
400	5	48.00	0.350	8	111.75	0.623	13	117.75	0.698	18	127.50	0.763
450	5	53.75	0.395	8	115.00	0.645	15	140.00	0.918	21	152.25	0.930
500	6	49.00	0.395	8	118.75	0.748	14	151.75	0.928	19	126.25	0.885
SE	0.406	2.277	0.160	0.590	2.853	0.159	0.662	2.952	0.163	0.801	2.898	0.170
SD	1.316	41.471	0.205	2.788	65.109	0.202	3.510	69.713	0.213	5.128	67.195	0.230
LSD	0.831	4.638	0.328	1.209	5.811	0.325	1.357	6.013	0.334	1.640	5.904	0.347

DAT: Days after treatment, NL: Number of leaves, LA: Leaf area, STD: Stem diameter, SE: Standard error, SD: Standard deviation, LSD: Least significant different ($p<0.05$)

Table 2: Effect of NPK treatments on dry weight and fresh weight of *C. moschata*

Treatment (kg NPK ha^{-1})	Dry weight (g)	Fresh weight (g)
0	1.635	12.210
200	6.988	52.250
250	32.133	120.970
300	23.438	158.733
350	10.948	98.325
400	3.838	63.080
450	7.460	94.513
500	12.688	105.588
SE	1.140	2.372
SD	10.394	45.026
LSD	2.371	4.935

SE: Standard error, SD: Standard deviation, LSD: Least significant different ($p<0.05$)

350 kg ha^{-1} treatment gave the highest number of leaves (Table 1). The leaf area and stem diameter obtained from 300 kg ha^{-1} treatment after 10 DAT (152.50 cm , ^{2}0.843 cm), 17 DAT (265.75 cm^2, 1.063 cm), 24 DAT (271.50 cm^2, 1.245 cm) and 31 DAT (277.75 cm^2, 1.273 cm), respectively. Abd El-Aziz (2007) reported that lower level (4 g pot^{-1}) significantly increased plant height, number of leaves, number of branches, root length, diameter of stem and leaf area by about (29.4, 62.1, 58.3, 39.7, 46.2 and 44.3%, respectively) compared with the control croton plant. This trend has been reported by Olufolaji *et al.* (2002) in a comparative evaluation study on soil and foliar applied fertilizer on growth and yield of *Celosia argentea*, they reported increase in leaf area and fruit yield. Oad *et al.* (2001) reported that application of NPK fertilizer doses equally showed efficiency of producing taller plants, more branches, increased number of siliqua, lengthy siliqua, bold seeds in siliqua and heavier seed index, which in-turn increased seed yield and oil content of the crop. Omotoso and Shittu (2007) reported that the fertilizer NPK significantly increase growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with fresh leaf, root and stem weight been higher in treatments that received 300 NPK kg ha^{-1} than those that received 0 and 150 NPK kg ha^{-1} while application of 250 kg ha^{-1} of NPK gave the highest number of leaves and stem girth (Awodun *et al.*, 2007).

Effect of NPK on the soil nutrient content: The initial chemical compositions of the soil used in this study are presented in Table 3. The organic matter, total nitrogen, exchangeable Ca, Mg and K were quite high except pH and available phosphorus contents of the soil when compared with the work of Ayeni (2010). The soil pH is slightly acidic with the value of 5.94. Similarly, the organic matter and organic carbon were quite high when compared with the work of Ibeawuchi *et al.* (2007).

Table 4 presents results on soil nutrient composition 2 Weeks after Planting (WAP). The NPK treatments increased the OM, OC and nutrient content of the soil while the control showed reduction in OM, OC and all nutrients assessed except available P and K. Among treatments, 400 kg ha^{-1} had the highest value for N. The value was not significant at $p<0.05$ among NPK treatments but significant when compared with the control. The 400 kg ha^{-1} consistently increased the available P, Ca, Mg, OM and OC while 500 kg ha^{-1} gave the highest value for K and Na content of the soil. The pH values varied from control (5.78) to 500 kg ha^{-1} (7.32) while, the percentage ash content ranges from 90.9-93.6% for 500 and 300 kg ha^{-1}, respectively. The ash content was not significant among treatments.

However, the results obtained 6 WAP was not consistent with the results obtained 2 WAP. The trend changed and different treatments showed varied improvement to macro and micro-nutrients of the soil. The OM and OC were quite high with 350 kg ha^{-1} and P and Na at 500 kg ha^{-1} while 450 kg ha^{-1} gave the highest value for K, Ca and pH. Though not significant, 250 kg ha^{-1} gave the highest value for N. However, the control showed highest Mg content of the soil 6 weeks after planting (Table 5).

Table 3: Initial chemical properties of soil

Chemical properties	Values
Na (mg kg^{-1})	206.00
K (mg kg^{-1})	219.20
Ca (mg kg^{-1})	13.20
Mg (mg kg^{-1})	95.75
PO_4^{2-} (mg kg^{-1})	4.95
N (%)	0.22
OM (%)	8.20
OC (%)	4.77
Ash content (%)	91.80
pH	5.94

Table 4: Effect of NPK on soil nutrient composition, 2 weeks after planting (WAP)

Treatment (kg NPK ha^{-1})	N (%)	PO_4^{2-} (mg kg^{-1})	K^+ (mg kg^{-1})	Ca^{2+} (mg kg^{-1})	Mg^{2+} (mg kg^{-1})	Na^+ (mg kg^{-1})	OM (%)	OC (%)	Ash (%)	pH
0	0.126	28.875	311.200	1.750	84.250	149.10	8.100	4.710	91.900	5.78
200	0.245	16.913	1323.400	231.550	98.050	228.40	7.900	4.590	92.100	5.84
250	0.224	29.700	1535.250	287.000	150.450	151.00	7.900	4.590	92.100	5.82
300	0.329	49.500	2313.700	770.650	150.450	244.80	6.400	3.720	93.600	6.80
350	0.231	28.463	2390.550	421.050	123.050	277.80	11.200	6.510	88.800	5.82
400	0.371	49.500	2527.100	1293.850	181.650	326.05	19.200	11.160	80.800	5.66
450	0.371	48.675	3432.150	292.550	97.950	306.55	13.900	8.080	86.100	7.31
500	0.154	36.300	3698.850	393.300	141.700	837.10	9.100	5.290	90.900	7.32
SE	0.108	1.233	0.108	141.289	11.810	5.253	1.499	0.871	1.499	0.256
SD	0.093	12.170	0.093	399.626	33.404	220.717	4.239	2.464	4.239	0.723
LSD	0.225	2.565	0.225	293.882	24.565	10.925	3.117	1.812	3.117	0.532

SE: Standard error, SD: Standard deviation, LSD: Least significant different ($p<0.05$)

Table 5: Effect of NPK on soil nutrient composition, 6 weeks after planting (WAP)

Treatment (kg NPK ha^{-1})	N (%)	PO_4^{2-} (mg kg^{-1})	K^+ (mg kg^{-1})	Ca^{2+} (mg kg^{-1})	Mg^{2+} (mg kg^{-1})	Na^+ (mg kg^{-1})	OM (%)	OC (%)	Ash (%)	pH
0	0.147	4.1250	181.95	17.15	84.25	158.05	16.20	9.420	83.80	7.10
200	0.154	12.375	250.40	4.250	64.05	160.30	6.400	3.720	93.60	6.16
250	0.210	12.788	433.40	17.55	66.90	208.95	7.200	4.190	92.80	5.80
300	0.175	16.500	303.25	35.60	70.80	147.15	11.70	6.800	88.30	6.72
350	0.182	10.725	409.55	10.05	78.45	144.45	19.00	11.05	81.00	4.66
400	0.154	12.375	448.15	11.65	75.10	334.98	5.700	3.310	94.30	5.82
450	0.168	16.088	487.00	65.70	79.45	317.65	5.100	2.970	94.90	7.25
500	0.147	17.738	482.15	0.700	73.25	357.75	4.800	2.790	95.20	7.24
SE	0.052	0.7320	0.0520	8.810	2.375	3.3970	1.940	1.128	1.940	0.321
SD	0.022	4.2890	0.0220	24.919	6.719	92.327	5.487	3.191	5.487	0.908
LSD	0.108	1.5230	0.1080	18.325	4.941	7.0660	4.035	2.347	4.035	0.668

SE: Standard error, SD: Standard deviation, LSD: Least significant different ($p<0.05$)

CONCLUSION

The NPK fertilizer increased the leaf area, stem diameter, number of leaves and nutrient contents (N, P, K, Ca, Na and Mg) of the soil. The use of NPK fertilizer at an application range between 400 and 450 kg NPK ha^{-1} is therefore recommended for growing of *C. moschata* and improvement of the soil nutrients level.

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