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Response of Tomato to Nitrogen and Potassium Fertilization in Wetland Soils in Akwa Ibom State

T.O. Ibia, E. Antiaobong, A.D. Usoroh and I.D. Edem
Department of Soil Science, University of Uyo, P.O. Box 4240, Uyo, Nigeria

Abstract: The response of tomato (*Lycopersicon esculentum*) to Nitrogen and potassium application in two wetland soils in Akwa Ibom State was studied. The studies included comparative pot trial and field experiment using tomato, general characterization of the soils at the locations (Odiok Itam and Ayadehe), determination of the nutrient content of both locations. The main objective of the study was to determin the growth rate of tomato in these soils and assessing the response of tomato to nitrogen and potassium fertilizer application. The physical parameters of the soils showed slight textural variation between Odiok Itam and Ayadehe locations. The soils in Odiok Itam were loamy sand while that of Ayadehe was sandy clay loam. The chemical parameters showed that these soils were generally acidic with a mean pH (H_2O) value of 5.68 and a mean content of total N was 0.14%, while available K was 0.16 Cmol kg^{-1}. The mean available P content was 61.6 mg kg^{-1}. The response of tomato to nitrogen and potassium fertilizers application was quite appreciable in both pot trial and on the field. Results obtained from pot trials indicate that fertilizer combinations of 60 kg N, 60 kg K_2O ha^{-1} resulted in higher growth rates, flower production and fruit sets. Similarly, results obtained from field experiment gave the same trend with 60 kg N and 60 kg K fertilizer combination

Key words: Wetland, tomato, nitrogen, potassium, fertilizer

INTRODUCTION

Wetland (hydromorphic) soils are soils saturated with water for most parts of the year or throughout the year in some cases, such that the morphology of their profile horizons is influenced by continuous presence of water and poor drainage resulting in gleying and mottling of the profile (Ahn, 1970). Wetland soils are of immerse potential in agricultural production and in Nigeria it is estimated that wetlands span about 65,783 km^2 or 7.6% of its total land mass (Ojanuga *et al.*, 1996). In the far East, East indices, Egypt, Europe and United States of America, they are highly valued for their potential in lowland rice production. In the tropics, they are very useful in the production of sugarcane; some fiber crops and vegetables. There are also wide possibilities for dry season cropping (Eshett *et al.*, 1991; Eshett, 1992). Its high productive potential emanates from its improved fertility status due to the influence of water submergence. Both native and applied potassium have been found to be better utilized under this condition. Nitrogen fertility management is more effective when properly done.

Tomato is an indispensable constituent of the daily diet of over 100 million Nigerians. Factors that contribute to the low yield of tomato are genetic limitation and poor adaptation of many currently grown varieties to local environmental conditions, suboptimal levels of inputs such as fertilizer and inadequate control of weeds at critical stages of plant growth and diseases.

For wetlands of the state hitherto little exploited to be fully utilized, their characteristics must be studied and suitable fertilizer levels recommended. This is the focus of this research with particular interest in tomato as a test crop.

MATERIALS AND METHODS

Study area: The research was conducted in two locations with alluvial soils- Odiok Itam and Ayadehe in Itu near Uyo. The area is located in the south Eastern Nigeria between latitude 5°0' and 5°25' North and longitudes 7°37' and 8°10' East. The soils of these areas are saturated with after for most parts of the year or throughout the year in some cases and are riverine in nature.

The land was manually cleared. Pot experiments and field trials were carried out on tomato seedlings which have been raised in a nursery and transplanted after 4 weeks. Two weeks after transplanting Urea and Muriate of potash (CO $(NH_2)_2$ and K_2O)were applied to provide equal amounts of N and K at 0, 30, 60 and 90 kg ha^{-1} in each

Corresponding Author: Dr. Trenchard O. Ibia, Department of Soil Science, University of Uyo, P.O. Box 4240, Uyo, Nigeria

plot/pot. The pots were arranged in a Completely Randomized Design (CRD) with 3 replications, while the field trials was only conducted at Odiok Itam in a randomized Complete Block Design (RCBD) with 4 replications and a spacing of 30×30 cm. fertilizer was applied by top dressing. Pot trials under shade lasted for 3 months as well as the field trails.

Soil analysis: Preliminary studies involved taking soil samples from Odiok Itam and Ayadehe locations at 2 depths of 0.15 and 15-30 cm.

The samples were air dried and sieved using 2 mm sieve. Bulk soil sample were also collected and used for pot trials under shade. Particle analysis was done with Bouyoucos hydrometer method while chemical analysis was done as described by Sparks (1996) for pH (H_2O), organic. C. total N. available P. exchangeable bases (Ca, Mg, K, Na) exchange acidity, Effective Cation Exchange Capacity (ECEC) and percent base saturation.

RESULTS AND DISCUSSION

General soil properties: The soil at Odiok Itam was loamy sand containing 65.8% coarse sand 14.2% of fine sand, 5.4% silt and 11.6% clay, while Ayadehe soil was sandy loam with 55.3% coarse sand, 16.2% fine sand 5.9% silt and 22.6% clay. Both soils are relatively loose and will allow for better tomato roots penetration into the soil for proper absorption of available nutrients.

The soil was found to be mostly acidic with a mean pH (H_2O) value of 5.68 as shown in Table 1. Organic carbon contents were generally high on the surface horizons from the two locations with mean values of 3.40 and 2.60%, respectively. The mean content of total nitrogen for both soils was 0.14% which is considered generally low. For New Zealand soils, Blackmore *et al.* (1972) considered 0.3% nitrogen as critical level. However, using Sobulo and Adepetu (1988) criterion for soil fertility classification with respect to total nitrogen, the soils under study fall between low (0.1%) and medium (0.3%) class having mean total nitrogen generally less than 0.2% on the surface. The relative abundance of the exchange cations on the surface soils was similar, the abundance being in decreasing order of Ca>Mg>K>Na except for Ayadehe location where Na was similar to K. The level of Exchangeable Acidity (EA) was almost equal for the two locations and the base saturation of the soils was generally high.

Effect of different rates of N and k fertilizers on plants height: The growth rate of tomato planted in pot was quite appreciable both in Odiok Itam and Ayadehe soils (Fig. 1 and 2). The plant height at 2, 4, 6 and 8 weeks after transplanting showed significant differences ($p<0.05$) reflecting response of the plant to the nutrients applied. The higher the rate of N fertilizer used the taller were the tomato plants i.e., 0 kg N ha^{-1} control, 30<90 kg N ha^{-1}. In the field, the trend was similar (Fig. 3), with increasing plant height significantly ($p<0.05$) higher at higher doses, 8 weeks after transplanting. This response agrees with that reported on various food crops (Davis and Winsor, 1967; Cooke, 1982).

Table 1: Mean values of some physical and chemical parameters of Odiok Itam and Ayadehe wetland soils of Akwa Ibom State

	Locations					
	Odiok Itam			Ayadehe		
Soil parameter	A	B	Mean	A	B	Mean
Ec (ds m^{-1})	0.14	0.12	0.13	1.10	1.10	1.10
Coarse sand (%)	66.1	65.5	65.8	55.6	55.0	55.3
Fine sand (%)	14.2	14.2	14.2	16.6	15.8	16.2
Silt (%)	5.4	5.4	5.4	5.9	5.9	5.9
Clay (%)	12.2	11.0	11.6	22.6	22.6	22.6
Texture	LS	LS	LS	SCL	SCL	SCL
Ph (H_2O)	5.66	5.72	5.69	5.69	5.63	5.66
Org. C (%)	3.8	3.0	3.40	3.10	2.10	2.60
Total N (%)	0.16	0.16	0.16	0.12	0.12	0.12
Ca^{++} (cmol kg^{-1})	0.20	0.60	0.40	0.50	0.30	0.40
Mg^{++} (cmol kg^{-1})	0.27	0.31	0.29	0.26	0.28	0.27
K^+ (cmol kg^{-1})	0.15	0.15	0.15	0.16	0.16	0.16
Na^+ (cmol kg^{-1})	0.18	0.10	0.14	0.20	0.12	0.16
EA (cmol kg^{-1})	2.10	2.10	2.10	2.00	2.00	2.00
ECEC (cmol kg^{-1})	2.90	3.26	3.08	3.12	2.86	2.99
BS (%)	27.58	35.58	31.58	35.90	30.07	32.99
Av. P (mg kg^{-1})	53.60	52.0	52.80	70.08	70.00	70.00

A = 0-15 cm; B = 15-30 cm; ECEC = Effective Cation Exchange Capacity; EA = Exchangeable Acidity; BS = Base Saturation; Av. P = Available Phosphorus; LS = Loam Sand; SCL = Sandy Clay Loam

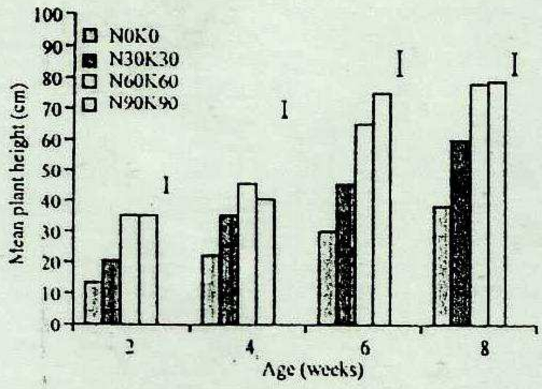

Fig. 1: Effect of different rates of N and K fertilizers on mean plant height at various weeks after transplanting (Odiok Itam soil-Pot trial)

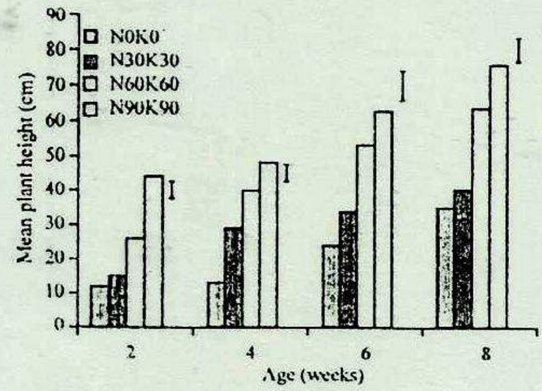

Fig. 2: Effect of different rates of N and K fertilizers on mean plant height at various weeks after planting after transplanting (Ayadehe soil-Pot trial)

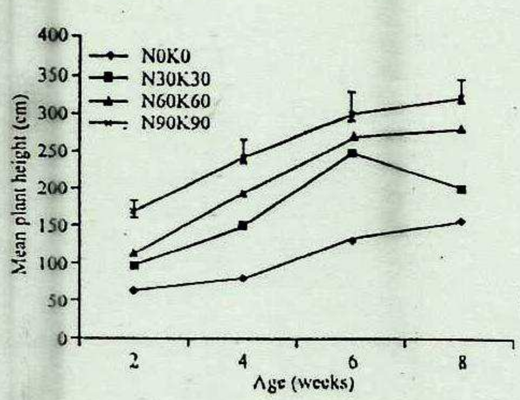

Fig. 3: Effect of different rates of N and K fertilizers on mean plant height at various weeks after planting under field condition (Odiok Itam soil)

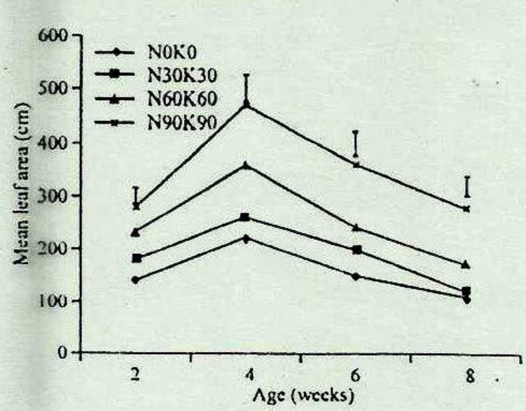

Fig. 4: Effect of different rates of N and K fertilizers on mean leaf area at various weeks after planting under field condition (Odiok Itam soil)

Effect of different rates of N and K Fertilizers on mean leaf area (cm^2): Nitrogen controls or regulates vegetable growth in crop plants including vegetables: leaf area was determined by measuring the length and breadth of 5 sampled leaves per plant and fitted into the Saxena and Singh (1965):

$$A = L \times B \times 0.75 \text{ cm}^2$$

Where:

A = Leaf area.
L = Length.
B = Breadth.
0.75 = A constant.

As shown in Table 2. the leaf area of the test plant significantly increased in both soils under pot trial in response to added N and K as well as time of observations (weeks after transplanting). Similarly, under field conditions in Odiok Itam (Fig. 4), mean leaf area showed significant differences between the treatments with the application of 90 kg N and 90 kg K ha^{-1}, showing remarkable distinction from 4 weeks after transplanting.

Effect of different rates of N and K fertilizer on mean flower number: Mean flower number as an index of response of tomato to N and K applications both in pot and field trials also showed significant trends. As shown in Fig. 5. in pot trials the application of N and K at 60 kg ha^{-1}, respectively, gave significantly higher number of flowers in both soils compared to other treatments. The same trend was shown in the field at Odiok Itam location (Fig. 6).

Effect of different of N and K fertilizer on yield of tomato: As already observed in Fig. 5 and 6, highest number of flowers obtained from the application of 60 kg N and 60 kg K is reflected in the overall trend with regards to fruits yield. For the pot trials (Table 3) at Odiok Itam soil. 60 kg N. 60 kg. K_2O ha^{-1} gave the highest fruit yield (259.10 kg ha^{-1}) which was significantly different from

Table 2: Effect of different rates of N and K fertilizers on mean leaf area at various weeks after transplanting at odiok itam and ayadehe

Soil	Treatment (kg ha•$^{-1}$)	Time (weeks) 2 WAT	4 WAT	6 WAT	8 WAT
Odiok Itam	N_0K_0	35.93	60.70	46.40	33.43
	$N_{30}k_{30}$	47.76	78.20	63.20	36.97
	$N_{60}K_{60}$	60.73	93.30	67.83	48.10
	$N_{90}K_{90}$	74.06	122.17	92.63	69.53
	L.S.D. (0.05)	10.81	14.27	14.78	15.98
Ayadehe	N_0K_0	21.77	53.53	34.93	22.07
	$N_{30}K_{30}$	40.82	75.07	41.93	26.60
	$N_{60}K_{60}$	57.27	88.50	69.10	35.30
	$N_{90}K_{90}$	76.46	169.07	84.50	41.97
	L.S.D. (0.05)	11.23	11.32	11.42	13.76

WAT = Weeks After Transplanting

Table 3: Effect of different rates of N and K fertilizer on mean tomato yield (pot trials)

Treatment (kg ha•$^{-1}$)	Locations Odiok Itam (kg ha•$^{-1}$)	Ayadehe(kgha•$^{-1}$)
N_0K_0	20.73	1.87
$N_{30}K_{30}$	24.10	6.07
$N_{60}K_{60}$	259.10	102.92
$N_{90}K_{90}$	218.52	89.65
L.S.D. (0.05)	69.92	63.89

Table 4: Effect of different rates of N and K fertilizers on mean tomato yield under field condition

Treatments (kg ha•$^{-1}$)	Odiok Itam (kg ha•$^{-1}$)
N_0K_0	19.38
$N_{30}K_{30}$	24.20
$N_{60}K_{60}$	285.55
$N_{90}K_{90}$	218.50
L.S.D. (0.05)	37.60

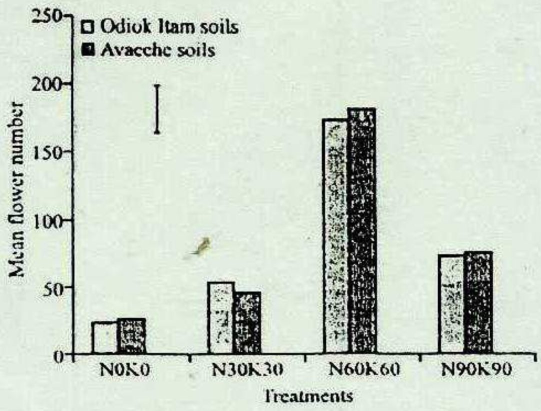

Fig. 5: Effect of different rates of N and K fertilizers on mean flower number (shade or pot trials)

yield of (218.52 kg ha•$^{-1}$) for 90 kg N and 90 kg K ha•$^{-1}$ treatment. The same trend was recorded for Ayadehe with 102.92 kg ha•$^{-1}$ at 60 kg N and 60 kg K application compared to 89.65 kg ha•$^{-1}$ at 90 kg N and 90 kg K treatment. However, there was no significant difference at $p<0.05$ between treatment 30 kg N, 30 kg K_2O ha•$^{-1}$ and the control as shown in Table 3. There was significant difference in fruit yields for the field study ($p<0.05$) as shown in Table 4. Fruits produced by tomato plants that

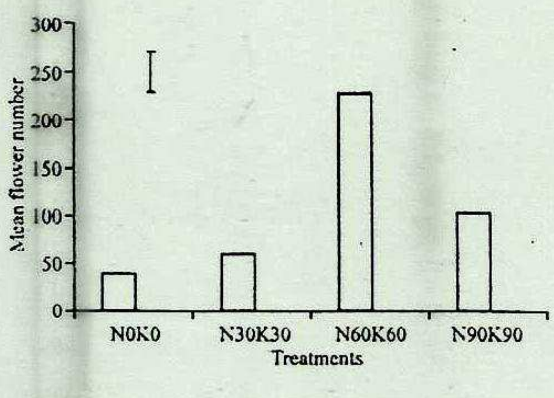

Fig. 6: Effect of different rates of N and K fertilizers on mean flowering number under field condition (Odiok Itam soil)

received 90 kg N ha•$^{-1}$ were characterized by small fruits, poor uneven colour, darken stem ends and culling leaves. These agree with the findings of Cottman (1988), who observed that in tomato excess nitrogen could cause delay in fruit setting slow ripening and increased fruit defects. At a fertilizer level of 60 kg N, 60 kg K_2O ha•$^{-1}$ there was increased flower quality and early ripening of tomato which confirms the recommendations of 60 kg N, 60 kg P_2O_5 and 60 kg K_2O ha•$^{-1}$ for south eastern Nigeria by Sobulo *et al.* (1975).

CONCLUSION

This study has shown that there is much hope for the vast mass of wetland in Nigeria estimated as about 65,783 km^2 or 7.6% of its total land mass. High rate of nitrogen fertilizer seem to suppress tomato yield but encourage vegetative growth, whereas high rates of potassium fertilizer tended to encourage flowering resulting in good fruit setting and enhances high yield.

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