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Evaluation of Growth and Yield Parameters of Two Ginger Varieties in Different Soils of Cross River State, Nigeria

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Abstract

A greenhouse study was conducted to evaluate the effects of growth and yield parameters of two ginger varieties UGI (yellow ginger) and UG II (Black ginger) in different soils of Cross River State, Nigeria. The soils for the screen study were collected from fifteen (15) locations (Akamkpa, Mfamosing, Obubra, Ediba, Akpet I, Bawop, Betukwel, Bishere, Ogoja, Ugep, Greek Town, New Netim, Ikot Omin, Nde and Bendeghe) to represent the five major parent materials in the State namely; Basement complex, Shale, Sandstone, Coastal Plain Sand and Basalt and the two ginger varieties used were UG I (yellow ginger) and UG II (Black ginger). The screen house experiment was a split – plot design with three replicates, the ginger varieties occupied the main plot and the fifteen soil types the sub plot. The plant parameters accessed include plant height, number of leaves, number of shoot and yield. The result of the soils analysis showed that the soils were acidic with pH values ranging from 3.80 – 5.50, sandy and generally low in nutrients except the soils derived from Basement Complex. Rhizome yield in the studied soils showed that Akamkpa soils performed best followed by Mfamosing and Akpet I for UG I variety with the following fresh rhizome weights 72.3, 69.1 and 61.6grammes. While the Akamkpa soils also performed best followed by the Ugep and Bendeghe soils for the UG II variety with the following fresh rhizome weights 67.8, 64.3 and 48.8gms and the UG I variety had higher yield compared to UG II variety, with 17.9%.

Key words: Soils, Ginger Varieties, Growth Parameters and Yield

1. Introduction

Ginger (*Zingiber Officinale Roscoe*) is a monocotyledonous crop which produces rhizomes that serve as the ginger of commerce. The rhizome is not a true root as is the case with cassava (*Manihot esculenta*) but a modified underground stem similar to yams (*Discorea Spp*) which produce stem tubers. It is perennial herb but treated on an annual crop under cultivation. The underground rhizome are thick, hard and much branched, giving rise to primary, secondary and tertiary roots which are about 1.5-2.5cm in diameter. The underground stem or rhizome produces erect leafy shoots, between 30 and 100cm, which are unbranched, thin and formed by sheathing petioles of the leaves. Propagation is always by portions of the rhizome.

Soils characteristic are determined by the type of parent material, depth, texture, relief and drainage. The geologic and geomorphic setting greatly influence the soils derived from them. The soils of Cross River State are formed from three major geologic groups namely the recent alluvial deposits and the tertiary coastal plain sands which cover about 10 percent of the state, the sedimentary formation/deposits with paralic sequence of sandstones, shale and silt stone, constituting about 45 percent of the total surface area and the Igneous and Metamorphic rocks occupying another 45 percent of the State surface area reported by Bulk-trade [1]. The sandstones and shale deposits occur to the immediate North of the coastal plain sands while the basement complex rocks comprising of granites, gneisses, schist and basalts occur mostly to South Eastern and North Eastern parts of the State.

In Nigeria, literature is scanty in the areas of fertilizer requirement for ginger especially in the Southern part of Nigeria, of which Cross River State is part and the most suitable Soil type for ginger production. This study was therefore conducted to provide information on the suitability of Soils of Cross River State for ginger production with the sole aim of improving the current low productivity and yield of ginger plant in Cross River State, Nigeria.

2. Materials and Method

The ginger rhizomes with an average weight of 5grammes were planted at a depth of 5cm in the plastic buckets. Planted plants' were watered, weeds removed by hand as the need arose and same rate of N, P and K fertilizers were applied once to the crops till maturity. The applied rate was 1gm (Urea), 0.4gm (SSP) and 0.5gm (K_2O). The experiment was conducted at Obubra (06^0 5^1, 8^0 20^1E).

Soil samples were taken from the top soil of 15 locations across the State from five parent materials namely Basement complex, Shale, Sandstone, Coastal Plain and Basalt. These were the major soil types found in the State. In each location samples were collected from six different spots with no history of any cultivation and bulked together to form composite sample. These bulked soil samples were collected and used for the screen house study while the samples for analysis were air dried and ground to pass through a 2mm sieve. Particle size analysis was determined by the hydrometer method [2], soil reaction (pH) was measured in a 1:2.5 Soil/Water suspension using a glass electrode pH meter [2]. Organic Carbon was estimated in 1g soil samples by the dichromate wet oxidation method [2] while total nitrogen was determined using the macro-kjeldahl digestion procedure [3], available phosphorus was determined by extraction with acid fluoride using the Bray P-2 method [4]. Exchangeable cations were leached from soil with neutral normal ammonium acetate solution [5]. The exchangeable K and Na were determined using the EEL flame photometer while Ca and Mg were estimated using versenate titration method [5]. Exchangeable acidity (H^+ + Al^{3+}) was determined using IN Kcl extraction procedure [5]. Effective cation exchange capacity of the soils were computed by summing up the ammonium acetate extracted bases and exchangeable acidity and the Base Saturation was obtained by expressing the sum of the exchangeable bases as percentages of the effective cation exchange capacity.

The composite soil samples from the 15 locations, each weighting 10kg were put into ten litre plastic buckets. The two ginger varieties planted were UGI (yellow ginger) and UGII (Black ginger). The experiment was is split- plot design with three replications. The two ginger varieties occupied the main treatment while the fifteen soil types were assigned to the sub treatments. There were a total of thirty treatment combinations replicated three times to give ninety experimental units. The agronomic characters and yield were analysed using the statistical method as described by Wahua [6].

Records of agronomic parameters taken eight weeks after planting (8WAP) at every two weeks interval for five months include; plant height, number of leaves per plant, number of shoots per plant and fresh rhizome yield. Plant height was measured with a meter rule from the base of the Crop (the last point of the soil in the bucket) to the tip of the inflorescence, number of leaves and number of shoots was measured by counting.

3. Results and Discussions

The physical and chemical properties of the soils are generally very strongly acidic with pH ranging from 3.81 in Akamkpa and New Netim to 5.5 in Nde and Ugep (**Table 1**). The soils were generally sandy in texture. The sand content ranged from 56.7% in the Sub Soil in Mfamosing to 90.3% in the top soil in Ogoja while clay content varied from 3.0% in Nde (top soil) to 29.2% clay in the (sub soil) in Mfamosing. The soils were generally low in Organic Carbon with values ranging from 3.8gkg^{-1} in the Subsoil at Ugep to 20.3gkg^{-1} in the top soil of Creek Town. Soil organic carbon was higher in the top soil than the subsoil with mean values of 10.0gkg^{-1} to 8.59gkg^{-1} respectively. Available P content of the soils ranged from 2.75mgkg^{-1} in the top soil of Mfamosing to 34.20mgkg^{-1} in the subsoil of Ogoja. Total N in the soils ranged from 0.30 gkg^{-1} in the subsoils of Ikot-Omin and Ogoja to 1.80gkg^{-1} in the subsoil at Akamkpa. Total N was generally higher in the top soil and lower in the subsoil. The values of C : N ratio ranged from 12.0 to 21.1 and 7.1 to 19.2 for surface and subsurface soils, respectively.

Table 1: Physical and chemical properties of the studied soils

s/n	Location	Parent Materials	Depth (cm)	pH 1:2.5	Sand (%)	Silt (%)	Clay (%)	Textural Class	Org. C. gkg^{-1}	Org. matter gkg^{-1}	AV.P mgkg^{-1}	T N gkg^{-1}	Ca (Cmolkg^{-1})	Mg (Cmolkg^{-1})	K (Cmolkg^{-1})	Na (Cmolkg^{-1})	Exch Acidity (Cmolkg^{-1})	ECEC (Cmolkg^{-1})	Base Sat %	C/N Ratio
1.	Akamkpa	Basement Complex	0-15	3.8	75.3	19.7	5.0	ls	16.5	28.5	8.12	1.30	1.6	0.6	0.08	0.06	4.72	7.06	33.15	13.1
			15-30	3.8	67.4	22.3	10.3	sl	13.20	22.70	9.08	1.80	1.8	0.5	0.08	0.05	4.18	6.61	36.61	7.3
2.	Mfamosing	Basement Complex	0-15	5.2	58.3	16.7	25.0	sl	6.40	11.00	2.75	0.50	1.2	0.2	0.08	0.06	2.80	4.33	35.34	13.1
			15-30	5.0	56.7	14.1	29.2	sl	6.10	10.50	2.90	0.40	1.8	0.5	0.10	0.06	2.61	5.07	48.52	15.1
3.	Obubra	Shale	0-15	5.2	74.1	21.7	4.0	ls	10.20	17.60	6.75	0.80	3.8	0.8	0.11	0.09	1.32	6.12	78.43	13.1
			15-30	5.1	68.6	22.3	9.1	sl	9.40	16.17	7.82	0.50	3.1	0.6	0.09	0.09	1.30	5.18	74.90	19.1
4.	Ediba	Shale	0-15	5.0	87.3	7.7	5.0	s	3.80	9.70	4.50	0.40	2.0	0.2	0.08	0.07	1.72	4.07	57.74	14.1
			15-30	5.1	78.6	8.4	13.0	sl	3.50	8.94	6.70	0.40	2.1	0.7	0.10	0.08	1.70	4.68	63.68	13.1
5.	Akpet I	Sandstone	0-15	4.7	70.3	16.7	13.0	ls	15.00	25.90	4.87	1.20	2.2	0.6	0.09	0.06	2.56	5.73	55.32	21.1
			15-30	4.5	66.4	15.5	18.1	sl	17.30	19.44	5.92	0.90	2.5	0.7	0.15	0.10	2.01	5.46	63.19	19.2
6.	Bawop	Sandstone	0-15	5.1	66.3	19.7	14.0	sl	14.40	24.80	3.25	1.20	2.2	0.6	0.09	0.06	1.24	4.19	70.41	12.0
			15-30	5.0	64.6	18.2	17.2	sl	10.20	17.54	3.30	0.80	2.0	0.6	0.07	0.06	1.12	3.85	70.91	13.1
7.	Betukwel	Sandstone	0-15	5.2	71.3	14.7	14.3	sl	8.40	14.50	4.62	0.70	2.0	0.4	0.09	0.07	1.96	4.52	56.64	12.1
			15-30	4.9	69.9	15.0	15.1	sl	7.10	12.21	4.60	0.70	1.8	0.8	0.07	0.08	1.82	4.57	60.18	10.1
8.	Bishere	Sandstone	0-15	4.6	71.3	14.7	14.0	sl	10.40	17.90	4.37	0.80	1.2	0.2	0.08	0.06	3.52	5.06	30.43	13.1
			15-30	4.2	70.1	13.4	16.5	sl	8.00	13.76	4.39	0.88	1.2	0.3	0.06	0.05	3.48	5.29	34.22	9.1

Table1: Cont.

s/n	Location	Parent Materials	Depth (cm)	pH 1:2.5	Sand (%)	Silt (%)	Clay (%)	Textural Class	Org. C. gkg^{-1}	Org. matter gkg^{-1}	AV.P $mgkg^{-1}$	T N gkg^{-1}	Ca ($Cmolkg^{-1}$)	Mg ($Cmolkg^{-1}$)	K ($Cmolkg^{-1}$)	Na ($Cmolkg^{-1}$)	Exch Acidity ($Cmolkg^{-1}$)	ECEC ($Cmolkg^{-1}$)	Base Sat %	C/N Ratio
9.	Ogoja	Sandstone	0-15	5.3	90.1	8.7	1.0	S	7.80	13.40	30.50	0.60	4.0	0.4	0.12	0.09	1.20	5.81	79.35	13.1
			15-30	5.0	83.1	8.4	3.5	Ls	5.40	9.29	34.20	0.30	5.1	0.8	0.11	1.10	1.09	8.20	86.71	18.1
10.	Ugep	Sandstone	0-15	5.5	77.3	12.7	10.0	Sl	5.60	6.60	3.62	0.70	3.0	0.6	0.10	0.09	1.28	5.07	74.75	13.1
			15-30	5.0	70.2	13.4	16.4	Sl	5.20	6.02	3.79	0.50	3.8	0.3	0.15	0.11	1.30	5.66	77.03	7.1
11.	Creek Town	Coastal plain sand	0-15	4.2	67.6	15.7	16.7	Sl	20.30	34.92	16.30	1.41	2.6	0.4	0.46	3.70	1.25	8.41	85.14	14.1
			15-30	4.0	72.6	13.7	13.7	Sl	16.40	28.21	12.50	1.20	1.4	0.2	0.40	3.25	1.05	6.30	84.00	14.1
12.	New Netim	Coastal plain sand	0-15	3.8	89.3	4.7	6.0	Ls	5.40	9.30	13.00	0.40	1.0	0.2	0.06	0.05	1.40	2.71	48.34	14.1
			15-30	3.8	78.2	8.0	13.8	Sl	5.00	8.60	15.20	0.50	1.1	0.6	0.08	0.09	1.11	2.98	62.75	10:1
13.	Ikot Omin	Coastal plain sand	0-15	5.4	76.1	19.7	4.0	Ls	6.60	11.40	17.25	0.50	3.0	1.0	0.10	0.07	5.69	5.69	73.29	13.1
			15-30	5.5	68.1	24.7	1.2	Sl	6.00	10.32	16.03	0.30	3.2	1.3	0.14	0.09	5.12	9.85	48.02	13.1
14.	Nde	Basalt	0-15	5.1	81.3	15.7	3.0	Ls	9.80	16.90	4.25	0.80	2.2	0.4	0.09	0.07	2.36	5.12	53.91	12.1
			15-30	5.3	78.6	14.7	6.7	Ls	8.20	14.10	4.20	0.80	2.0	0.4	0.15	0.07	1.98	4.60	56.96	10.1
15.	Bendeghe	Basalt	0-15	4.5	69.34	19.7	11.0	Sl	9.60	16.60	4.75	0.80	2.8	1.4	0.09	0.08	3.28	7.65	57.12	12.1
			15-30	4.3	64.9	14.9	20.2	Scl	7.71	12.33	4.82	0.60	2.3	1.9	0.11	0.07	2.94	7.32	59.84	13.1

S = sand, SL = sandy loam, LS = loamy sand and SCL = sandy clay loam

Exchangeable Ca ranged from 1.10cmolkg^{1} in soils of New Netim and Mfamosing to 5.10cmolkg^{-1} in Bishere to 1.90cmolkg^{-1} in the sub soil of Bendeghe. The trend in exchangeable K is similar to that of magnesium and calcium. It ranged from 0.07cmolkg^{-1} in Bawop to 0.26cmolkg^{-1} in the soil of Bishere with a mean value of 0.17cmolkg^{-1}. Exchangeable Na was relatively more abundant in the soil derived from Coastal Plain Sand. Total soil exchangeable acidity ranged from 1.05cmolkg^{-1} in Creek Town to 5.69 cmolkg^{-1} in Ikot Omin with an average of 2.42 cmolkg^{-1}. The effective cation exchange capacity (ECEC) ranged from 3.85 cmolkg^{-1} in Bawop subsoil to 9.85 Cmolkg^{-1} in Ikot Omin subsoil. Most of the soils are dominated by exchangeable Hydrogen as indicated by the high values of base saturation ranging from 30.43% in Bishere to 86.71% in Ogoja.

Growth parameters

The effect of source of soils on plant height of the two ginger varieties indicate that at 8 WAP, the tallest plants were produced in the soil from Akamkpa, followed by Nde on which the UGII variety was planted while the soils also from Akamkpa produced the tallest plants followed by Akpet 1 for the UGI variety. The shortest plants were produced by soils of Ediba for UGI while the soils of Ikot Omin produced the shortest plants for UGII variety. The means of the two varieties are not significantly different at 5% probability level. The progressive plant height growth from 10 WAP to 20 WAP showed that the tallest plants found on the soils of Akamkpa, at 8 WAP had plant heights of 58.7cm and 64.7cm for UG I and UG II varieties, and progressive plant height of 66.7cm and 73.3cm at 20 WAP for UG I and UG II respectively. This was again closely followed by the soils of Nde which had plant heights of 56.3cm and 59.0cm at 8 WAP to a maximum of 63.7cm and 68.3cm for UG I and UG II respectively at 20 WAP. Also there was no significant difference between the means of the two varieties at 5% probability level. As indicated in **Table 2**, at 20 WAP, it shows that growth in terms of plant height had cease for almost all plants, indicating that plants had attain their maximum plant height.

The effect of source of soils on number of leaves of the two ginger varieties as shown in **Table 3** indicate that at 8 WAP, more leaves per plant were produced by the soils from Akamkpa, Betukwel and Ogoja for UG II variety while for UG I variety, the soils of Bawop and Betukwel had the highest number of leaves and the least number of leaves were produced by the soils of Ediba and Akpet I for UG I and UG II varieties respectively. The location mean between the two varieties was not significantly different at 5% probability level while the location x variety interaction showed a significant difference at 5% probability level for the UG I variety but not for the UG II variety. Similar trend were also observed on the progressive increase in the number of leaves as was the case for plant height. Bawop soils produced the highest number of leaves with a mean of 15.33 at 10 WAP had the highest number of leaves at 26 WAP (26.70) and was closely followed by the soils of Bendeghe (25.00) while the soil of Akpet I produced the least number of leaves (17.00).

Table 2: Data on mean values of UG I & UG II varieties for plant height from 8 WAP – WAP 26 in cm

		8 WAP		10 WAP		12 WAP		14 WAP		16 WAP		18 WAP		20 WAP		22 WAP		24 WAP		26 WAP	
s/n	**Location**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**
1.	Akamkpa	58.7	64.7	59.8	65.7	62.3	66.7	62.7	67.7	63.3	69.7	65.00	71.67	66.67	73.3	66.67	73.33	66.67	73.33	66.67	73.33
2.	Mfamosing	52.3	42.0	53.8	43.7	56.0	44.5	57.4	44.7	58.7	50.3	62.33	51.00	63.07	52.0	63.67	52.17	63.67	52.17	63.67	52.17
3.	Obubra	52.7	45.7	53.7	47.0	54.0	49.0	55.7	50.3	56.3	52.7	59.77	54.67	61.3	56.50	62.00	56.57	62.00	56.57	62.00	56.57
4.	Ediba	40.0	46.7	42.0	48.2	42.6	49.6	44.3	50.7	47.0	50.8	47.57	52.10	48.48	52.33	48.83	52.33	48.83	52.33	48.83	52.33
5.	Akpet 1	56.7	46.3	58.3	51.7	60.3	54.3	61.7	55.7	63.7	56.7	64.67	57.67	65.7	58.67	66.00	58.67	66.00	58.67	66.00	58.67
6.	Bawop	44.7	48.0	46.7	50.0	49.3	52.0	51.7	54.0	52.7	55.3	54.33	57.00	57.3	58.0	59.33	56.97	59.33	56.97	59.33	56.97
7.	Betukwel	49.0	45.0	51.3	47.0	52.3	48.7	54.3	51.0	60.0	52.3	60.4	53.67	60.7	56.7	61.40	56.97	61.40	56.7	61.40	56.7
8.	Bishere	47.0	50.7	47.8	52.2	50.7	56.0	51.3	57.7	56.4	59.0	57.00	62.67	58.0	63.67	58.00	63.67	58.00	63.67	58.00	63.67
9.	Ogoja	41.0	44.0	43.0	45.7	44.7	47.3	46.2	49.3	48.0	51.9	51.33	53.67	52.40	56.15	54.67	57.33	54.67	57.33	54.67	57.33
10.	Ugep	46.7	39.5	48.3	41.4	49.7	46.3	52.0	48.1	53.5	51.3	56.67	52.00	58.0	52.0	58.67	52.00	58.67	52.00	58.67	52.00
11.	Creek Town	54.0	34.7	54.8	36.7	56.3	39.0	57.0	39.3	58.0	42.0	59.77	44.33	60.0	46.0	60.00	46.00	60.00	46.00	60.00	46.00
12.	New Netim	42.5	43.3	43.7	45.3	45.2	48.0	47.0	49.7	47.0	52.7	50.33	54.33	52.3	55.67	52.33	55.67	52.33	55.67	52.67	55.67
13.	Ikot-Omin	45.3	25.3	47.3	29.5	48.7	30.8	48.7	32.7	51.3	34.7	54.67	37.00	57.0	39.3	58.67	40.77	58.67	40.83	58.67	40.83
14.	Nde	56.3	59.0	59.0	61.3	60.0	63.3	60.0	64.7	61.7	66.7	62.67	67.00	63.7	68.33	64.00	68.33	64.00	68.33	64.00	68.33
15.	Bendeghe	44.7	44.7	48.0	46.3	49.7	47.3	49.7	49.3	51.7	51.3	55.33	51.67	56.3	53.33	57.33	53.33	57.33	55.33	57.33	55.33
	Variety Mean	48.8	46.8	50.5	47.4	52.0	49.6	53.8	50.6	55.6	53.0	57.23	54.96	57.9	56.1	59.44	56.22	58.75	56.52	59.39	56.52

	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP	24 WAP	26 WAP
LSD (0.05)	11.81	11.59	11.43	11.63	10.63	10.99	10.74	12.25	10.76	10.67
Location	4.31	4.23	4.14	4.25	4.01	3.92	4.47	3.93	3.90	3.96
(Loc x Var)	16.71	16.39	16.04	16.45	15.54	15.19	17.32	15.21	15.09	15.09

Table 3: Data on mean values of UG I & UG II varieties for number of leaves from 8 WAP – WAP 26

s/n	Location	8 WAP		10 WAP		12 WAP		14 WAP		16 WAP		18 WAP		20 WAP		22 WAP		24 WAP		26 WAP	
		UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II	UG I	UG II
1.	Akamkpa	11.0	12.33	13.00	14.33	15.00	16.33	17.33	18.33	20.33	20.33	21.00	23.33	22.67	25.33	22.67	25.33	22.70	24.00	22.70	24.0
2.	Mfamosing	9.00	8.67	10.33	10.33	12.33	11.67	15.00	13.67	18.00	16.33	20.00	18.67	21.00	20.33	21.00	20.33	21.00	20.30	21.00	20.30
3.	Obubra	8.00	7.67	10.00	9.33	11.33	12.00	13.33	15.00	16.33	17.00	18.33	19.00	21.33	20.33	22.00	20.33	22.00	20.30	22.00	20.30
4.	Ediba	7.00	9.67	8.67	11.67	10.67	14.00	12.33	16.00	15.67	17.33	17.67	22.00	20.67	23.67	20.67	23.67	20.70	23.70	20.70	23.70
5.	Akpet 1	7.67	6.00	9.67	8.67	12.00	9.67	14.00	11.33	15.67	13.00	17.33	15.00	18.67	17.00	20.67	17.00	19.00	17.00	19.00	17.0
6.	Bawop	13.33	8.33	15.33	10.33	17.33	12.33	19.33	15.33	20.67	17.33	22.67	19.67	24.67	22.33	18.67	23.33	26.70	23.30	26.70	23.30
7.	Betukwel	12.33	12.33	14.33	13.67	16.33	16.00	16.33	17.33	18.00	19.33	21.00	22.00	22.00	24.00	23.00	24.67	23.00	24.70	23.00	24.70
8.	Bishere	8.33	7.67	9.67	9.00	11.33	12.33	13.67	14.33	18.67	15.67	18.67	18.00	19.33	19.00	19.33	19.33	19.00	19.30	19.00	19.30
9.	Ogoja	9.33	12.33	11.33	14.33	12.67	16.00	14.67	18.67	16.33	19.67	19.00	21.67	21.00	23.67	22.00	24.67	22.00	24.70	22.00	24.70
10.	Ugep	8.33	8.33	9.0	10.33	12.33	14.00	14.67	15.67	15.0	17.33	17.67	19.67	19.67	19.67	19.67	19.67	19.70	19.70	19.70	19.70
11.	Creek Town	10.33	7.00	11.67	9.33	14.00	11.00	15.67	13.00	16.33	18.00	20.67	18.63	22.67	21.67	22.67	21.67	22.30	21.70	22.30	21.70
12.	New Netim	7.33	7.67	8.67	9.67	10.67	11.33	12.67	13.33	14.33	16.67	16.33	16.67	18.00	18.67	18.00	18.67	18.00	18.70	18.00	18.70
13.	Ikot-Omin	10.00	9.33	12.00	11.33	14.00	13.33	16.00	15.33	17.67	16.67	18.67	18.67	20.00	20.00	21.33	21.00	21.30	21.00	21.30	21.00
14.	Nde	8.33	6.67	10.67	10.00	12.00	12.00	14.00	15.67	15.00	16.33	16.00	18.67	17.00	21.00	18.33	21.00	18.30	21.00	18.30	21.00
15.	Bendeghe	9.00	7.67	10.33	11.33	12.33	13.33	14.67	21.00	17.00	22.33	18.33	23.67	20.67	24.33	21.33	25.00	21.30	25.00	21.30	25.00
	Variety Mean	9.29	8.89	10.84	10.89	12.96	13.02	15.00	15.60	17.00	17.69	20.20	19.67	20.42	21.40	21.18	21.71	21.10	21.60	18.40	21.60
LSD (0.05)		2.37		2.76		2.77		3.25		3.19		3.25		3.15		2.76		2.91		2.91	
Location		0.87		1.01		1.01		1.19		1.17		1.91		1.15		1.07		1.07		1.07	
(Loc x Var)		3.35		3.90		3.90		4.59		4.51		4.62		4.46		3.99		3.99		3.99	

Table 4: Data on mean values of UG I & UG II varieties for number of shoot from 8 WAP – WAP 26

		8 WAP		10 WAP		12 WAP		14 WAP		16 WAP		18 WAP		20 WAP		22 WAP		24 WAP		26 WAP	
s/n	**Location**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**	**UG I**	**UG II**
1.	Akamkpa	2.67	2.67	2.67	3.33	3.33	3.67	3.33	3.67	3.33	3.67	3.33	3.67	3.33	3.67	3.33	3.67	3.33	3.67	3.33	3.67
2.	Mfamosing	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67
3.	Obubra	1.67	1.00	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	2.00	1.33	2.00	1.33	2.00	1.33	2.00	1.33	2.00	1.33
4.	Ediba	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67	1.33	1.67
5.	Akpet 1	2.00	1.67	2.00	1.67	2.33	1.67	2.33	1.67	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00
6.	Bawop	2.00	1.67	2.00	1.67	2.33	1.67	2.33	1.67	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67	2.67	1.67
7.	Betukwel	1.33	1.00	1.33	1.00	1.33	1.33	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	2.33	1.67	2.33	1.67	2.33
8.	Bishere	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
9.	Ogoja	1.33	2.00	1.33	2.33	1.67	2.33	1.67	2.33	1.67	2.33	1.67	2.33	2.00	2.67	2.00	2.67	2.00	2.67	2.00	2.67
10.	Ugep	1.00	2.33	1.67	2.67	2.00	3.00	2.00	3.33	2.00	3.33	2.00	3.33	2.00	3.33	2.00	3.33	2.00	3.33	2.00	3.33
11.	Creek Town	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00	2.33	1.00
12.	New Netim	1.67	1.00	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33	2.67	1.33
13.	Ikot-Omin	1.67	1.33	1.67	1.67	1.67	1.67	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33	2.00	2.33
14.	Nde	1.67	1.67	2.00	2.00	2.33	2.00	2.67	2.00	2.67	2.00	2.67	2.00	2.67	2.00	2.67	2.00	2.67	2.00	2.67	2.00
15.	Bendeghe	1.67	1.67	1.67	1.67	11.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
	Variety Mean	1.67	1.56	1.89	1.73	1.96	1.80	2.02	1.89	2.09	1.93	2.09	1.96	2.11	1.98	2.11	2.00	2.11	2.02	2.11	2.02

	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP	24 WAP	26 WAP
LSD (0.05)	0.67	0.81	0.94	0.97	0.98	0.98	1.10	1.02	1.04	1.04
Location	0.24	0.31	0.34	0.35	0.35	0.36	0.36	0.37	0.38	0.38
(Loc x Var)	0.94	1.41	1.34	1.37	1.39	1.38	1.41	1.44	1.47	1.47

Effects of source of soils on number of shoots of the two ginger varieties reveals that at 8 WAP, the soil of Akamkpa on which the UG II variety was planted had the highest number of shoot followed by soils of Ugep while the soils of Akamkpa still produced the highest number of shoot, followed by the soils of Mfamosing and Greek Town for the UG I variety and the least number of shoots were produced by the soils of Ugep for the UG I variety. As shown in **Table 4**, there was a progressive increase in the number of shoots from 10 WAP to 14 WAP and from 16 WAP to 26 WAP, it does appear that the number of shoots remain the same, indicating that the growth of shoot had ceased.

In terms of yield, the study revealed that the soils of Akamkpa produced the highest rhizome yield, followed by Mfamosing and Akpet I for the UG I variety (yellow ginger) with the following fresh rhizome weights of 72.3, 69.1 and 61.6 grammes while Akamkpa also produced the highest rhizome yield followed by Ugep and Bendeghe for the UG II variety (black ginger) with the following fresh rhizome weights 67.8, 64.3 and 48.8 grammes. Soils from Ediba produced the least rhizome yield and weighed 16.3 gramames. The mean values of the two ginger varieties were significantly different at 5% probability level as shown in **Table 5**.

Rhizome yield in order of magnitude were as follows:-

UGI variety:- Akamkpa > Mfamosing > Obubra >Akpet I> Ikot- Omin > New Netim > Ugep > Bawop > Nde> Betukwel > Ogoja > Bishere > Greek Town > Bendeghe > Ediba.

UG II variety – Akamkpa > Ugep > Bendeghe > Akpet I > Nde > Mfamosing > Betukwel > Ogoja . Ikot Omin > Obubra > Bawop > New Netim > Bishere > Creek Town > Ediba

4. Discussion

The soils of the forest zone of Cross River State, Nigeria have been known to be generally acidic. The low pH values of the soils of the coastal plain sand confirmed the description of the soils as the “acid sands” of Southern Nigeria as reported by Kamalu *et al*; [7] ; Attoe and Amalu [8] . Acid soils can reduce plant growth and yield by increasing soil concentration of H^+, Al^{3+} and Mn^+ to toxic levels, decreasing the availability of Ca^{2+}, Mg^{2+} and Mn^+ and adversely affecting yield as reported by Mengel [9]. The “acid sand” is known to have low CEC, low base saturation and often suffer from multiple nutrient deficiencies, such soils in their natural form are not likely to support the growth and development of crop to attain their genetic yield potentials as reported by Ohiri [10]. Soils derived from shale had the highest mean pH values while soils derived from coastal plain had the lowest pH mean values. With sand content ranging from 56.7 to 90.1%, the soils can be termed as sand. Sandy soils are generally very porous, with high infiltration rate, fragile and therefore easily prone to erosive forces reported by Lekwa and Whiteside [11]. This could therefore be one of the factors accounting for the high rate of erosion and the numerous gullies clotting the area. The high clay content in sub soils is in line with the observations of other workers as reported by Ojenuga [12]; Attoe and Amalu [8]. This trend is attributed to the nature of the parent material.

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Table 5: Fresh rhizome yield of the two ginger varieties in the different soil locations (gms)

s/n	Location	Parent Material	Variety		Mean
			UG 1	UG 11	
1.	Akampka	Basement Complex	72.3	67.8	70.1
2.	Mfamosing	Basement Complex	69.1	46.4	57.7
3.	Obubra	Shale	62.6	37.1	49.8
4.	Ediba	Shale	19.3	16.3	17.8
5.	Akpet 1	Sandstone	61.1	48.3	55.0
6.	Bawop	Sandstone	53.7	36.9	45.3
7.	Betukwel	Sandstone	49.3	46.2	47.47
8.	Bishere	Sandstone	43.7	31.7	37.7
9.	Ogoja	Sandstone	49.0	40.9	44.9
10.	Ugep	Sandstone	53.8	64.3	59.0
11.	Creek Town	Coastal plain sand	42.3	25.7	34.0
12.	New Netim	Coastal plain sand	55.0	32.8	43.3
13.	Ikot-Omin	Coastal plain sand	56.3	40.3	48.3
14.	Nde	Basalt	53.6	48.2	50.9
15.	Bendeghe	Basalt	37.8	48.8	43.3
	Mean		51.7	42.4	

LSD (0.05)
Location 13.19
Variety 4.82
Location X Variety 18.66

The soil organic carbon is typical of the humid tropics with high rainfall and temperature and therefore high rate of mineralization as reported by Aune and Lal [13]. With the average soil organic carbon being generally less than 10gkg^{-1}, most of the soils can be said to be low in organic matter and hardly exceeded the 20gkg^{-1} critical value for soil organic matter as reported by Sys [14]. The only exceptions to this are the soils of Akamkpa, Akpet I, Bawop and Greek Town. Aune and Lal [13] indicated that soil organic matter below 20gkg^{-1} would have a pronounced effect on soil productivity and that at soil organic matter of 0.37%; yields were reduced by 50%.

Generally, soil organic matter was less than the critical level of Adeoye and Agboola [15] for optimum crop production in South-Western Nigeria. Generally, total nitrogen was low with the exception of the soils in Akamkpa (Basment complex) all the other soils had total N less than the critical level of 1.5gkg^{-1} set for crop production in Southern Nigeria as reported by Enwezor *et al*., [16]; Adeoye and Agboola [15]. The low nitrogen level and C:N ratio could be attributed to the high rate of mineralization and the subsequent high rate of leaching that accompanied the heavy rains associated with the forest zone of South-Eastern Nigeria reported by Osodeke [17] . Therefore a major factor that could limit crop production in the zone is soil total N. This becomes more important since the farmers are resource poor and have very little or no access to organic fertilizers.

The range of exchangeable Ca and Mg are similar to those reported by several other workers for the soils of the humid topics (Agbede [18]; Kamalu *et al*., [7] ; Enwezor *et a*l., [19] and on soils of Cross River State (Attoe and Amalu [8], Attoe et al; [20] . About 66% of the soils had Mg level higher than the 0.4cmolkg^{1} critical level for most soils as reported by Adeoye and Agbola [15]. These soils therefore do not require Ca and Mg application for optimum yield of crops. However, they may be applied as liming materials since the pH of the soils are low and exchangeable acidity high. Enwezor *et al*.,[19] classified exchangeable K into low if the values are less than 0.2cmolkg^{-1}, medium between 0.2-0.4cmolkg^{-1} and high above 0.4 cmolkg^{-1}. Based on these, all the soils with the exception of Creek Town (coastal plan sand) are all deficient in K. This trend is similar to the findings of Agbede [18] who attributed the trend to the native of the parent material.

The effective cation exchange capacity in the soils were generally low, below 10 cmolkg^{-1}. This is characteristic of low activity clay of South Eastern Nigeria dominated by Kaolinite as reported by Udo [21]; Juo [22]; Ojanuga [12]; Agbede [18]; Attoe and Amalu [8]. The relatively higher CEC in the Coastal Plain Sand and Basement Complex soils could be due to the presence of traces of smectite in these soils (Juo [22]; Agbede [18]. The CEC dominated by exchangeable acidity as reflected in the base saturation is attributed to the high degree of weathering of the soil and high rainfall pattern of the state, resulting in the displacement of the basic cations with acidic cations such as Hydrogen and Aluminium as reported by Juo [22] and Attoe *et al*., [20].

Most of the soils were low in available P. With the exception of soils in Akamkpa, Ogoja, Creek Town, New Netim and Ikot-Omin, all others have P level below the range of 8 – 12mgkg^{-1} regarded as the critical level of P for crop production in Southern Nigeria (Udo [23] ; Enwezor *et al*;[19]; Smyth and Cravo [24]. The relatively high P value of the Coastal Plain Sand is in agreement with the findings of Udo and Ogunwale [25] who reported the Coastal Plain Sand are generally high in available P and therefore do not require P fertilizers.

Varietal differences in respect to plant height were not significant at 5% probability level, though, the soils of Akamkpa gave the tallest plants for both the UG I and UG II varieties with plant height measuring 66.7cm and 73.3cm respectively. Similar results were earlier on obtained by Chukwu and Emehute [26] and Musa [27]. However, the growth and development pattern of both varieties were similar.

In terms of the number of leaves, the result revealed that the soils of Bawop on which the UG I variety was planted had the highest number of leaves (26.70) and was closely followed by Bendeghe soil on which the UG II variety was plant (25.00) while the soil of Akpet I on which the UG II variety was planted has the least number of leaves (17.0). Though, some soils still recorded increases in the number of their leaves as evident by the soils of Akamkpa, Betukwel and Ogoja, this apparent difference could be due to genetic variations between varieties.

The study also revealed that the highest number of shoot where produced by the soils of Akamkpa on which the UG II variety was planted while the least number of shoot was produced by the soil of Creek Town on which UG II variety was planted. There was no significant difference at 5% probability level between the means of the two varieties.

5. Conclusion

This study showed a difference in growth and yield parameters of ginger in the different soils the study was conducted. However, in this study only soil type could have accounted for the differences in yield since other environmental factors of climate were eliminated by conducting the experiment in the green house. The higher rhizome yield in Akamkpa, Mfamosing, Obubra, Ugep and Akpet I could be due to the relatively higher concentration of nutrients and the relatively high pH values in the soils. However, the reverse is the case in Ediba soil where the lowest rhizome yield was recorded. The UG I variety out yielded the UG II variety by 17.9%. The yield, advantage over UG II is in conformity with Musa (1986) findings wherein UG I variety gave 14.3% greater yield than the UG II variety. The larger number of shoots per plant (which may be genetic) in UG I could be a reason for this difference since each shoot is capable of accumulating assimilates for onward translocation to the sink (rhizome).

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