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Responses of Five Cassava Varieties on the Vegetative Growth Parameters to Organic and Inorganic Fertilizer.

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Abstract
Cassava (*Manihot esculenta*) Euphorbiaceae is a woody shrub, and a very important food crop in the tropics. Cassava farmers prefer to raise their seedlings from stem cuttings for their desired cultivars instead of seeds. This is because; raising seedlings with seeds is not of immediate economic value. However there is need to involve the seeds for desired cultivars before the multiplication through stem cuttings, because Hybridization work depends upon seed germination. There appears to be insufficient information on the effect of organic and inorganic fertilizer on the vegetative growth performance of some cassava varieties. Therefore this study was conducted to improve upon the germination of seeds and to determine the effect of some organic and inorganic fertilizer on the vegetative growth performance, yield of seedlings of cassava varieties. Seed from five cassava varieties (IITA-TMS- IBA980505, IITA-TMS-IBA0110368, IITA-TMS-IBA30572, IITA-TMS-070593 and IITA-TMS-TMEB419) were collected from International Institute of Tropical Agriculture (IITA) Ibadan, Oyo state. Viability test of seeds were carried out using floatation method. Seeds were then subjected to some pre-treatments including ordinary water, hot water and concentrated sulphuric acid. Seedlings were raised in a 25 cm by 20 cm black polythene bags at the Pure and Applied Botany Screen house of Federal University of Agriculture Abeokuta. Seedlings were subjected to 0.2 g and 0.5 g Nitrogen Phosphorus Potassium fertilizer (NPK), cow dung and compost treatment separately at 8 weeks after planting. Treatments were replicated three times in a complete randomized design. Growth parameters measured induced plant height, leaf area (LA), number of leaves, number of nodes and internodes, leaf dry weight and leaf fresh weight. The relative Growth Rate (RGR), Net Assimilated Rate (NAR) and Leaf Area Ratio (LAR) of the seedling were also determined. The data obtained in the study were subjected to Analysis of Variance and means separated by Duncan's Multiple Range Test at $P \leq 0.05$. Results showed that Normal water treatment enhanced germination of seed most (70 %) in all varieties. The highest value in plant height and number of leaves were obtained in IITA-TMS-IBA070593 varieties with mean values of 83.67±20.17cm and 7.67±0.67cm when supplemented with 0.2 g and 0.5 g cow dung treatments. Highest values in internode were recorded in IITA-TMS-IBA070593 varieties with mean value 23.33±2.84 when supplemented with 0.2 g cow dung treatment. Highest value of the node were obtained in IITA-TMS-IBA30572 with mean value of 25.33±1.45 with 0.5 g NPK at 16 WAP, the highest value of LA were obtained from IITA-TMS-TMEB419 with 94.00±1.15 with 0.5 g cow dung. Highest RGR (0.72 gg^{-1}week)and LAR (7121.42) cm^2g^{-1} were recorded in IITA-TMS-IBA30572, treated with 0.2 g cow dung, while highest NAR (0.56g^{-1} $week^{-1}$) were recorded in IITA-TMS-IBA070593 treated with 0.5 g cow dung.

Keywords: Cassava varieties, cassava seeds, growth, compost, Organic manure

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Introduction

Cassava, Manioc or Yuca (*Manihot esculenta* Krantz) of the plant family, Euphorbiaceae is a tropical plant mostly used for food and animal feeds in Asia, Africa and South America where it originated from. It is an important food and industrial crop in tropical and subtropical regions of the world (Egesi *et al.,* 2007).

Cassava is the largest source of food carbohydrate in the tropics, after rice and maize, providing a basic diet for over half a billion people (Claude *et al.,* 1990). It is one of the most drought-tolerant crops, capable of growing on marginal soils (FAO, 1995).

Nigeria is world largest producer of cassava while Thailand is the largest exporter of dried cassava. In terms of taste, there are the sweet and bitter varieties. Cassava varieties contain cyanide, a toxic anti-nutritional factor which can cause death, partial paralysis and goiter (FAO, 1990).

Cassava is a perennial crop and easily propagated through stem cuttings and by seed. Matured cassava roots, fully laden with stored starch is long and tapered with a firm, homogenous flesh enclosed in a detachable rind (Vierra *et al.,* 2008).

A new hybrid of cassava is the yellow cassava with three varieties UMUCASS 36, UMUCASS 37 and UMUCASS 38. These have been developed by International Institute of Tropical Agriculture (IITA) in Nigeria for high concentration of ß Carotene, a precursor of vitamin A. All these varieties can also be used in the industrial preparation of starch and ethanol. The leaves are edible vegetable (Egesi *et al.,* 2006).

The maintenance of sexual propagation system through active cross breeding allow constant gene recombination and gene combination of different origins (Viera et al., 2008; Elias *et al.,* 2001).

However, one of limiting factors to genetic breeding in cassava is the low and uneven germination of viable seeds. These may be due to some environmental factors and some innate causes such as seed dormancy.

Cassava farmers always want to raise their seedlings from stem cuttings because of the immediate economic value. However, there is the need to go for desired cultivars before stem multiplication. This study was therefore conducted to improve upon the seedlings raised from seeds of 5 varieties of cassava including the yellow cassava whose seedlings have been successfully raised from their pre-treated seeds.

Materials and Methods

Seed collection

The seed of five varieties of cassava (*Manihot esculenta* Krantz.) were obtained from cassava breeding unit ofInternational Institute of Tropical Agriculture Ibadan, Oyo State. The varieties includes: IITA-TMS-IBA0110368, IITA-TMS-IBA980505, IITA-TMS-IBA30572, IITA-TMS-IBA070593, and IITA-TMS-TMEB419, This research was carried out at the laboratory and Screen house of the Department of Pure and Applied Botany of Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Seed germination test

Twenty (20) seeds were plated in 9cm sterilized petri-dish containing a what-man filter paper already moistened with water and arranged in three replicates using complete randomized design (CRD) method based on the treatment and replicate in the department of Pure and Applied Botany Laboratory (Agboola *et al.,* 2004).

Viability test

Viability test of seeds was carried out using the simple floating method of the International Seed Testing Association (ISTA, 2012).

Collection and preparation of soil

Initial germination test was also carried out in polythene bags of 25cm by20cm. The soil sample used for raising the seedlings was Sandy-loamy soil, and it was collected at 5cm depth, after which it was sieved to remove pebbles and stones, and then poured into dark Botany of Federal University of Agriculture, Abeokuta (FUNAAB).

Plant growth experiment under manure and chemical fertilizer treatment

The treatments used on seedlings were manure (Cow dung {CD} and compost {CM}) and chemical fertilizer N.P.K. (15-15-15) and vegetative parameters collected were,

Plant height (cm)
The heights of the control and treated plants were measured and recorded from ground to the terminal bud using a metre rule.

Number of leaves
The total number of leaves on each of the treated plants were counted and recorded.

Leaf area (cm^2)
Leaf area was calculated using a graph sheet (cm^2). Leaf area was determined using the formula below. Leaf Area = Number of holes covered by the leaf × $0.04cm^2$.

Number of node
The total number of node and internodes on each of the treated plants were counted and recorded.

Statistical analysis
Data collected were expressed as means ± standard deviation. The means were compared by Analysis of Variance (ANOVA) and significant means were separated using Duncan Multiple Range Test (DMRT), level of significance was set at $P<0.05$.

Results

Effect of cow dung, compost manure and NPK on height of cassava varieties studied
Results showed that height of IITA-TMS-0110368 applied with the treatments showed significant differences ($P<0.05$) when treated with 0.5 CD from 10 WAP through 16 WAP (Table 1). NPK at 0.2g produced significant increase ($P<0.05$) on the height of IITA-TMS-980505 from 11 WAP through 16 WAP compared with other treatment investigated (Table 2). It was noticed that height of IITA-TMS-IBA30572treated with 0.5 NPK showed significant increase from 12 WAP through 16 WAP (Table 3). Similar significant increase ($P<0.05$) was observed in the height of IITA-TMS-IBA070593 treated with 0.2 CD throughout the period of the study (Table 4). Results showed that 0.5 CM increased significantly ($P<0.05$) height of IITA-TMS-TMEB419 throughout the study. Similar observation was recorded on the same variety of cassava treated with 0.2 NPK from 12 WAP through 16 WAP.

Effect of cow dung, compost manure and NPK on Number of leaf of cassava variety
Study on the effects of the treatments repaved that IITA-TMS-IBA0110368showed that 0.5 NPK and 0.2 cow dung increased the parameter at 11 and 12 WAP as well as 15 and 16 WAP. The treatments showed significant difference ($P<0.05$) on the Number of leaf of IITA-TMS-IBA980505at week 13 after planting to 16 week after planting. Number of leaf of IITA-TMS-IBA980505 treated with 0.5 CD at 13 WAP (5.33) and 14 WAP (7.07) were significantly higher as well as the values of the cassava (6.00) 14 WAP and 7.33 16 WAP (Table 7). Further study on the lobe of the cassava variety showed significant increase ($P<0.05$) in lobe of the IITA-TMS-IBA30572treated with 0.5 CD at 15 WAP and 16 WAP (7.00).

Table 9 revealed that there was no significant difference ($P>0.05$) in the Number of leaf of IITA-TMS-IBA070593 at 9 and 10 WAP while at 11 WAP through 16 WAP, the Number of leaf of IITA-TMS-IBA070593 treated with 0.5 cow dung showed significant increase ($P<0.05$) compared with number of the parameter recorded in other treatments under this study. Table 5 revealed that IITA-TMS-TME419treated with 0.5 cow dung at 10 WAP through 13 WAP showed significant increase ($P<0.05$) in their Number of leafwhile at 14 WAP through 16 WAP, Number of leaf of IITA-TMS-TME419 treated with 0.5 compost manure showed significant ($P<0.05$) increase compared with the number of the parameters in the cassava variety treated with other treatments under investigation.

Table 1: Effect of cow dung, manure and NPK on height of IITA-TMS-IBA0110368

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	5.33±0.88^{a}	6.33±0.88^{d}	7.67±1.67^{b}	10.33±2.84^{c}	12.00±4.04^{b}	14.67±4.70^{b}	19.00±6.03^{a}	22.33±7.42a
0. 5NPK	15.00±5.50^{a}	18.33±5.2^{b}	21.33±4.67^{ab}	25.00±3.79^{ab}	28.00±3.22^{ab}	31.33±2.03^{ab}	34.00±2.00^{ab}	41.67±2.19^{ab}
0. 2CD	14.33±2.60^{a}	20.00±2.51^{a}	25.00±2.51^{a}	30.33±2.60^{a}	35.00±2.89^{a}	40.00±3.06^{a}	44.33±3.38^{a}	37.33±12.25^{ab}
0. 5 CD	8.00±3.05^{a}	10.67±4.37^{c}	14.33±5.67^{ab}	19.00±7.55^{ab}	23.00±8.54^{ab}	26.67±9.84^{ab}	31.67±10.84^{ab}	54.67±5.20^{a}
0. 2 CM	13.33±5.78^{a}	16.67±5.90^{b}	18.67±5.90^{ab}	23.00±5.57^{ab}	25.33±5.36^{ab}	27.67±5.04^{ab}	31.00±5.13^{ab}	37.00±4.16^{ab}
0. 5CM	13.33±2.40^{a}	17.33±3.18^{b}	20.33±2.60^{ab}	25.00±2.60^{ab}	29.33±1.76^{a}	32.67±1.33^{b}	37.00±0.58^{ab}	41.33±0.88^{ab}

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT).

Table 2: Effect of cow dung, manure and NPK on height of IITA-TMS-IBA980505

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	18.67±2.19^{a}	23.00±1.53^{a}	29.33±1.33^{b}	35.33±1.33^{a}	39.00±1.53^{a}	44.00±2.08^{a}	48.00±2.00a	56.67±6.00^{a}
0. 5 NPK	10.00±2.65^{a}	14.00±3.06^{a}	18.67±3.18^{ab}	25.00±4.04^{ab}	29.33±3.33^{ab}	34.67±2.33^{ab}	41.33±1.76^{ab}	50.67±3.71^{ab}
0. 2CD	12.00±1.00^{a}	15.00±0.58^{a}	18.67±0.33^{ab}	29.00±2.08^{ab}	33.00±2.52^{ab}	37.33±3.84^{ab}	42.00±5.20^{ab}	50.67±1.33^{ab}
0. 5 CD	11.33±2.67^{a}	15.67±3.38^{a}	20.33±3.28^{ab}	25.67±3.84^{ab}	30.33±2.85^{ab}	35.33±2.91^{ab}	41.33±3.71^{ab}	56.00±2.65^{a}
0. 2 CM	14.00±2.51^{a}	17.33±1.86^{a}	21.33±1.76^{ab}	24.00±2.30^{ab}	29.00±1.73^{ab}	34.00±1.00^{ab}	38.00±1.00^{ab}	42.00±1.16^{b}
0. 5CM	11.00±3.79^{a}	14.67±4.91^{a}	18.33±5.92^{ab}	21.67±6.74^{b}	26.00±6.43^{b}	30.33±6.33^{b}	33.67±6.98^{b}	40.67±5.46^{b}

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 3: Effect of cow dung, manure and NPK on height of IITA-TMS-IBA3052

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	20.67 ± 4.06^{a}	24.33 ± 6.39^{a}	28.33 ± 7.88^{a}	32.33 ± 9.39^{b}	37.33 ± 11.14^{b}	41.67 ± 10.81^{b}	50.67 ± 14.71^{d}	57.33 ± 14.35^{d}
0. 5NPK	18.33 ± 3.84^{a}	26.00 ± 3.06^{a}	32.33 ± 4.18^{a}	40.33 ± 5.24^{b}	50.00 ± 6.66^{a}	57.67 ± 7.36^{a}	67.67 ± 10.40^{a}	75.67 ± 8.41^{a}
0. 2CD	19.33 ± 1.67^{a}	25.33 ± 2.33^{a}	31.67 ± 3.28^{a}	37.33 ± 3.53^{b}	43.67 ± 4.70^{b}	51.67 ± 3.84^{b}	59.00 ± 2.89^{b}	70.67 ± 1.33^{b}
0. 5 CD	17.67 ± 3.28^{a}	23.67 ± 7.22^{a}	27.33 ± 7.33^{a}	31.67 ± 7.31^{b}	35.33 ± 7.69^{b}	43.33 ± 6.94^{b}	55.00 ± 5.86^{c}	64.67 ± 4.67^{c}
0. 2 CM	12.67 ± 2.02^{a}	16.00 ± 3.46^{a}	20.67 ± 3.71^{a}	26.00 ± 5.03^{c}	33.33 ± 7.13^{b}	38.67 ± 7.69^{c}	48.00 ± 9.54^{d}	55.00 ± 8.54^{d}
0. 5CM	13.67 ± 2.33^{a}	19.67 ± 3.84^{a}	25.33 ± 4.41^{a}	31.33 ± 5.78^{b}	37.33 ± 6.77^{b}	41.67 ± 6.44^{b}	46.67 ± 6.33^{e}	49.67 ± 5.84^{e}

Mean ± standard error followed different superscripts are significantly different at $P<0.05$ using Duncan's multiple range test (DMRT)

Table 4: Effect of cow dung, manure and NPK on height of IITA-TMS-IBA070593

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	19.67 ± 3.28^{ab}	21.33 ± 9.53^{ab}	29.33 ± 12.02^{ab}	36.00 ± 12.49^{ab}	42.00 ± 13.31^{ab}	48.67 ± 14.62^{ab}	60.00 ± 16.92^{ab}	66.33 ± 17.15^{b}
0. 5NPK	6.67 ± 3.33^{c}	8.00 ± 4.00^{b}	10.00 ± 5.00^{b}	13.67 ± 6.98^{b}	18.33 ± 8.01^{b}	23.33 ± 9.56^{b}	33.33 ± 9.82^{b}	43.33 ± 12.33^{c}
0. 2CD	29.33 ± 7.33^{a}	34.33 ± 7.36^{a}	42.00 ± 8.08^{a}	45.67 ± 9.74^{a}	50.33 ± 10.87^{a}	57.00 ± 13.01^{a}	70.33 ± 14.90^{a}	83.67 ± 20.17^{a}
0. 5CD	14.33 ± 1.20^{bc}	19.00 ± 1.53^{ab}	25.33 ± 3.53^{ab}	31.67 ± 3.84^{ab}	40.67 ± 3.71^{ab}	50.67 ± 2.91^{ab}	60.33 ± 4.84^{ab}	70.33 ± 5.90^{b}
0. 2CM	8.00 ± 1.16^{bc}	10.67 ± 1.45^{b}	12.67 ± 1.45^{b}	18.67 ± 2.90^{b}	24.00 ± 3.46^{ab}	28.67 ± 4.33^{ab}	36.00 ± 5.51^{c}	45.67 ± 7.62^{c}
0. 5CM	8.33 ± 0.88^{bc}	9.33 ± 1.45^{b}	11.00 ± 1.73^{b}	18.00 ± 0.58^{b}	23.00 ± 0.00^{b}	25.00 ± 1.73^{b}	37.67 ± 4.33^{c}	45.00 ± 8.66^{c}

Mean ± standard error followed different superscripts are significantly different at $P<0.05$ using Duncan's multiple range test (DMRT)

Table 5: Effect of cow dung, manure and NPK on height of IITA-TMS-TMEB419

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	18.33±0.88[ab]	25.33±0.88[ab]	33.67±7.21[ab]	43.00±7.50[a]	51.00±8.66[a]	58.67±8.67[a]	69.67±7.80[a]	85.67±10.93[a]
0.5NPK	19.00±4.50[ab]	24.00±4.16[ab]	32.00±5.69[ab]	37.67±7.75[b]	45.33±8.09[b]	53.33±8.45[b]	62.33±8.41[b]	71.00±9.64[ab]
0.2CD	9.67±3.71[b]	15.00±5.57[c]	20.00±6.56[b]	27.67±10.37[d]	37.00±11.59[c]	46.67±13.72[c]	59.67±16.19[b]	81.00±6.35[ab]
0.5CD	17.67±11.78[ab]	20.33±13.54[b]	23.67±15.56[b]	32.00±21.17[c]	35.67±29.50[c]	38.33±25.26[d]	41.00±27.03[c]	45.33±29.99[ab]
0.2CM	4.33±1.86[ac]	6.33±3.38[d]	9.67±5.36[c]	13.00±7.77[e]	15.67±9.53[d]	20.67±12.73[e]	26.00±16.26[d]	29.00±18.34[b]
0.5CM	22.00±7.50[a]	28.00±7.50[a]	35.00±1.73[a]	42.33±0.33[a]	50.67±0.33[a]	60.33±0.33[a]	68.00±1.16[a]	80.33±3.76[ab]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 6: Effect of cow dung, manure and NPK on lobes of IITA-TMS-IBA0110368

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	3.03±0.03[ab]	3.33±0.33[a]	3.33±0.33[b]	3.33±0.33[b]	4.00±0.00[a]	5.00±0.57[a]	5.66±0.67[ab]	5.67±0.67[ab]
0. 5 NPK	4.00±0.00[a]	4.33±0.33[a]	4.67±0.33[a]	4.67±0.33[a]	4.67±0.33[a]	5.67±0.67[a]	6.00±0.57[ab]	6.00±0.57[a]
0. 2CD	3.00±0.00[ab]	4.00±0.57[a]	4.67±0.33[a]	4.67±0.33[a]	4.67±0.33[a]	5.00±0.00[a]	6.67±0.33[a]	6.67±0.33[a]
0. 5 CD	2.67±0.67[b]	3.67±0.67[a]	4.00±0.57[ab]	4.00±0.57[ab]	4.00±0.57[a]	4.67±0.33[a]	4.67±0.33[b]	5.00±0.00[b]
0. 2 CM	3.67±0.33[ab]	4.67±0.33[a]	4.33±.33[ab]	4.33±0.33[ab]	4.33±0.33[a]	4.67±0.33[a]	5.33±0.33[ab]	5.33±0.33[ab]
0. 5CM	3.67±0.33[ab]	4.00±0.00[a]	4.00±0.00[ab]	4.00±0.00[ab]	4.33±0.33[a]	5.00±0.57[a]	5.67±0.33[ab]	6.00±0.57[a]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT).

Table 7: Effect of cow dung, manure and NPK on Number of leaf of IITA-TMS-IBA980505

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	3.01±0.01[a]	3.33±0.33[a]	3.67±0.33[a]	4.33±0.33[a]	4.67±0.33[ab]	5.33±0.33[ab]	6.33±0.67[ab]	6.33±0.67[ab]
0. 5 NPK	3.03±0.03[a]	3.00±0.00[a]	3.67±0.33[a]	4.01±0.01[a]	4.33±0.33[ab]	6.00±0.58[a]	6.67±0.33[ab]	7.33±0.33[a]
0. 2CD	3.04±0.03[a]	3.33±0.33[a]	3.33±0.33[a]	3.67±0.33[a]	4.33±0.33[ab]	5.67±0.33[ab]	6.37±0.69[ab]	6.34±0.67[ab]
0. 5 CD	3.03±0.03[a]	3.67±0.33[a]	4.00±0.58[a]	4.33±0.33[a]	5.33±0.33[a]	5.67±0.33[ab]	7.07±0.67[a]	7.04±0.37[ab]
0. 2 CM	3.00±0.00[a]	3.00±0.00[a]	3.67±0.67[a]	3.67±0.67[a]	3.67±0..67[b]	4.34±0.67[b]	5.67±0.67[b]	5.33±0.33[b]
0. 5CM	2.67±0.33[a]	3.03±0.58[a]	3.33±0.33[a]	3.33±0.33[a]	3.33±0.33[b]	5.00±0.00[ab]	5.37±0.31[b]	6.33±0.67[ab]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 8: Effect of cow dung, manure and NPK on Number of leaf of IITA-TMS-30572

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	3.33±0.33[a]	3.67±0.67[a]	4.33±0.67[a]	4.33±0.67[a]	5.00±0.00[a]	5.33±0.33[a]	6.00±0.58[b]	6.00±0.58[b]
0. 5 NPK	3.33±0.33[a]	3.67±0.33[a]	4.00±0.58[a]	5.00±0.00[a]	5.33±0.33[a]	6.00±0.58[a]	6.33±0.67[b]	6.33±0.67[b]
0. 2CD	3.00±0.00[a]	3.00±0.00[a]	3.00±0.00[a]	3.33±0.33[a]	5.00±0.00[a]	5.00±0.00[a]	5.33±0.33[b]	5.67±0.33[b]
0. 5 CD	3.00±0.00[a]	4.33±0.67[a]	4.33±0.67[a]	4.33±0.67[a]	4.33±0.67[a]	5.33±0.33[a]	700±0.33[a]	7.00±0.33[a]
0. 2 CM	3.00±0.00[a]	4.33±0.67[a]	4.33±0.67[a]	4.33±0.67[a]	4.33±0.67[a]	5.00±0.00[a]	5.33±0.33[b]	5.33±0.33[b]
0. 5CM	3.00±0.00[a]	4.33±0.33[a]	4.33±0.33[a]	4.67±0.33[a]	4.67±0.33[a]	5.33±0.33[a]	5.67±0.67[b]	5.67±0.67[b]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 9: Effect of cow dung, manure and NPK on Number of leaf of IITA-TMS-IBA070593

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	3.00±0.58[a]	3.00±0.58[a]	3.33±0.33[bc]	3.67±0.33[bc]	5.00±0.00[a]	5.33±0.33[ab]	6.00±0.57[b]	6.33±0.67[b]
0. 5 NPK	3.00±0.00[a]	3.67±0.67[a]	4.33±0.67[ab]	4.33±0.67[ab]	4.67±0.33[ab]	5.33±0.33[ab]	5.67±0.67[b]	6.00±0.58[b]
0. 2CD	3.33±0.33[a]	4.00±0.00[a]	5.00±0.00[a]	5.00±0.00[a]	5.07±0.67[a]	6.33±0.67[a]	7.00±0.00[a]	7.00±0.00[a]
0. 5 CD	3.00±0.00[a]	3.33±0.33[a]	3.33±0.33[bc]	3.33±0.33[bc]	4.67±0.33[ab]	6.00±0.00[ab]	6.67±0.33[b]	7.67±0.67[b]
0. 2 CM	3.00±0.00[a]	3.00±0.00[a]	4.00±0.00[abc]	4.00±0.00[abc]	5.00±0.00[a]	6.00±0.00[ab]	6.67±0.33[b]	7.33±0.33[b]
0. 5CM	2.67±0.33[a]	2.67±0.33[a]	3.00±0.00[c]	3.00±0.00[c]	3.67±0.67[b]	5.00±0.00[b]	5.67±0.33[b]	6.37±0.68[b]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 10: Effect of cow dung, manure and NPK on Number of leaf of IITA-TMS-IBATME419

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	2.33±0.33[ab]	3.00±0.58[b]	3.33±0.89[b]	4.00±1.00[ab]	4.00± 1..00[ab]	4.00± 1.00[ab]	4.33±0.67[ab]	4.33± 0.67[ab]
0. 5 NPK	2.67± 0.33[a]	2.67± 0.33[b]	2.67± 0.33[b]	3.00±0.58[ab]	3.33± 0.67[ab]	3.67±0.88[ab]	4.33±1.20[ab]	4.67±1.45[ab]
0. 2CD	2.33± 0.33[ab]	2.33± 0.33[b]	2.67± 0.33[b]	4.00±0.58[ab]	4.00± 0.58[ab]	4.67±0.33[a]	5.00±0.00[ab]	5.00±0.00[ab]
0. 5 CD	3.00± 0.00[a]	4.33±0.33[a]	5.00± 0.00[a]	5.00± 0.00[a]	5.00± 0.00[a]	5.00±0.00[a]	5.00±0.00[ab]	5.00±0.00[ab]
0. 2 CM	1.67± 0.33[b]	2.00± 0.57[b]	2.00±0.58[b]	2.33±0.88[b]	2.33±0.88[b]	2.33±0.88[b]	2.67±1.20[b]	3.00±1.00[b]
0. 5CM	3.00±0.00[a]	3.00±0.00[b]	3.00±0.00[b]	3.33±0.33[ab]	4.00±0.33[ab]	5.67±0.33[a]	6.33±0.67[a]	6.67±0.33[a]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Effect of cow dung, compost manure and NPK node of cassava varieties studied

Study on the effect of the treatments on the number of nodeofIITA-TMS-IBA0110368 revealed that 0.5 NPK and 0.2 CD increased node of the cassava variety from 11 WAP through 16 WAP (Table 11).Node of TMS-IBA980505 treated with 0.2 NPK were significantly higher (P<0.05) compared with node of the same variety of cassava treated with other treatments (Table 12). In addition, no significant variations were observed in the node of IITA-TMS-IBA30572 starting from 9 WAP to 12 WAP. This observation revealed significant difference (P<0.05) from 13 WAP to 16 WAP. Also, at 13 and 14 weeks after planting, node of the cassava variety treated with 0.2 and 0.5 of NPK and cow dung increased number of the node Similar significant (P<0.05) were observed in the treatments except 0.5CM at 15 and 16 WAP. Node of TMS 4 revealed that node of IITA-TMS-IBA-070593 treated with 0.2 CD showed significant increase at 10 WAP through 14 WAP. Similar observation were recorded in the cassava variety treated with 0.5 NPK at 15 and 16 WAP (Table 14). Results revealed that node of the cassava under the treatments showed significant differences (P<0.05). Node of TMS treated 0.5 NPK at 10 WAP to 16 WAP showed significant increase.

Effect of cow dung, compost manure and NPK on Leaf area of cassava varieties

Results revealed that the treatments produced significant difference (P <0.05) on the leaf of each the cassava varieties. It was observed that 0.5 cow dung increased significantly P < 0.05) in IITA-TMS-IBA30572 (74.33), IITA-TMS-IBA070593 (90.67) and IITA-TMS-TMEB419 (94.00) of the cassava while the parameters was significantly higher in IITA-TMS-IBA980505 (76.30) treated with 0.2 cow dung and IITA-TMS-IBA0110368 (17.00) treated with 0.5 cow dung (Table 16).

Results on the interactive effects of some fertilizer treatments on Relative Growth Rate ($gg^{1}week^{-1}$), Net Assimilation Rate ($gcm^{2-1}week^{-1}$) and Leaf Area Ratio ($cm^{2}g^{-1}$) of selected varieties of cassava (*Manihot esculenta* Krantz).

Table 17 shows the physiological parameters of different varieties of cassava treated with different levels of manures. Results revealed that the physiological parameters showed significant difference (p<0.05) on the cassava investigated. Leaf area ratio (4493.57), relative growth rate (0.30 and net assimilation rate (0.37) were significantly (p<0.05) higher in variety 1 of the cassava treated with 0.5 cow dung. Similar significant increase (p<0.005) were recorded in in LAR (5518.03), RGR (0.47) and NAR (0.39) in variety 2 treated with 0.2 cow dung as well as the parameters; LAR (6122.31), RGR (0.57) and NAR (0.39) in variety 3treated with 0.2 cow dung. Also LAR (5702.00), RGR (0.36) and NAR (0.41) and LAR (5571.90), RGR (37.33) and NAR (0.34) were recorded in variety four and five respectively.

Discussion

Cassava is grown in almost all the agro ecological zones in Nigeria and plays a prominent role in alleviating the food problem in the country because it thrives and produces stable yields under conditions in which other crops fail (Joy *et al.,* 2015). Deterioration in soil fertility is a critical agricultural challenge facing small holder farming including cassava production in different parts of Nigeria. Due to the high cost and uncertain availability of inorganic fertilizers, it is important to provide alternative sources of nutrients such as organic materials for better production of cassava. As a technical approach to improve soil fertility, cassava farmers in many countries including Nigeria introduced different fertilizer types either single or in combination with chemical fertilizers to improve soil's physical conditions for provision of important mineral such as calcium and magnesium and other micronutrients needed for improvement of vegetative characters and yield of cassava (Joy *et al.,* 2015).

Table 11: Effect of cow dung, manure and NPK on length of IITA-TMS-IBA011368 node

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	3.500±0.29[a]	4.00±0.33[a]	6.00±0.58[a]	7.50±0.86[a]	8.50±0.87[a]	9.00±1.15[ab]	10.500±1.44[ab]	13.00±1.73[ab]
0.5NPK	4.67±2.08[a]	6.667±2.03[a]	8.33±2.91[a]	10.33±2.60[a]	11.67±2.33[a]	13.00±1.73[a]	14.67±2.03[a]	16.33±2.02[a]
0.2CD	4.00±0.58[a]	6.00±1.00[a]	8.00±1.00[a]	9.67±0.67[a]	11.00±0.58[a]	12.67±0.33[a]	14.67±0.88[a]	15.67±0.67[ab]
0.5CD	4.00±1.00[a]	4.44±0.80[a]	5.33±0.88[a]	5.78±0.78[a]	6.67±1.86[a]	7.00±2.00[b]	8.00±2.00[b]	9.67±1.86[b]
0.2CM	5.78±0.78[a]	6.667±1.20[a]	8.22±0.97[a]	8.00±2.65[a]	8.33±2.73[a]	9.00±2.65[ab]	9.67±2.96[ab]	11.67±2.96[ab]
0.5CM	3.67±1.20[a]	5.333±1.86[a]	7.00±1.53[a]	9.33±1.33[a]	10.33±1.33[a]	11.33±0.88[ab]	13.00±1.73[ab]	14.67±1.45[ab]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 12: Effect of cow dung, manure and NPK on node of IITA-TMS-IBA960505

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	5.33±0.33[a]	6.66±0.33[ab]	8.66±0.33[a]	11.67±0.33[a]	13.66±0.33[a]	14.66±0.33[a]	15.00±0.58[a]	16.00+0.58[a]
0. 5 NPK	2.33±0.88[b]	3.33±1.33[b]	5.33±1.86[a]	7.33±2.33[b]	9.00±2.51[ab]	10.33±1.86[a]	12.00±1.53[a]	13.33±0.88[a]
0. 2CD	3.00±0.58[b]	3.33±0.33[b]	5.33±0.33[a]	7.3±0.33[b]	9.67±0.67[ab]	11.33±0.67[a]	12.33±0.88[a]	13.67±1.45[a]
0. 5 CD	2.67±0.33[b]	3.67±0.88[b]	5.66±0.88[a]	6.67±0.67[b]	8.66±1.20[b]	9.68±1.20[a]	11.00±1.73[a]	12.33±1.45[a]
0. 2 CM	3.67±0.33[b]	5.00±0.58[ab]	6.33±1.20[a]	7.67±1.45[b]	9.67±1.45[ab]	10.62±1.45[a]	12.33±1.67[a]	13.33±1.76[a]
0. 5CM	3.11±0.48[b]	4.00±0.58[b]	5.78±0.78[a]	8.00±1.00[ab]	10.22±1.31[ab]	8.66±3.33[a]	10.67±3.84[a]	12.67±3.33[a]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 13: Effect of cow dung, manure and NPK on length of IITA-TMS-IBA30572 node

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	7.67±0.88[a]	9.67±0.88[a]	12.67±1.33[a]	14.00±0.58[a]	16.33±0.88[a]	19.00±1.16[a]	21.00±1.00[a]	23.33±0.67[a]
0. 5 NPK	5.33±0.67[a]	8.33±1.20[a]	11.67±0.88[a]	14.33±0.33[a]	17.00±0.58[a]	20.00±1.16[a]	22.67±0.88[a]	25.33±1.45[a]
0. 2CD	6.67±0.88[a]	10.00±1.52[a]	12.33±1.67[a]	14.33±1.20[a]	17.00±1.16[a]	20.00±2.08[a]	22.33±2.33[a]	24.67±1.52[a]
0. 5 CD	7.67±0.88[a]	10.00±0.00[a]	12.33±0.33[a]	14.00±0.58[a]	15.67±0.67[a]	19.00±1.53[a]	21.00±1.53[a]	23.00±0.88[a]
0. 2 CM	5.33±0.67[a]	8.00±1.00[a]	11.00±1.16[a]	13.00±1.16[a]	15.00±1.16[b]	18.00±1.53[b]	20.00±1.53[a]	22.33±0.00[a]
0. 5CM	5.33±0.33[a]	7.00±0.58[a]	9.00±0.58[a]	10.33±0.67[b]	12.33±0.67[b]	14.00±0.58[b]	15.67±0.58[b]	18.00±0.67[b]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 14: Effect of cow dung, manure and NPK on length of IITA-TMS-IBA070593 node

Treatment	Weeks after planting (cm)							
	9WAP	10WAP	11WAP	12WAP	13WAP	14WAP	15WAP	16WAP
0.2NPK	6.22±0.97[ab]	7.00±3.21[a]	10.00±4.04[a]	12.67±5.04[a]	13.67±5.61[a]	15.00±5.69[a]	16.67±5.45[a]	18.67±5.90[a]
0. 5 NPK	4.67±0.67[ab]	7.00±1.00[a]	9.17±1.17[a]	11.66±1.67[a]	14.33±1.45[a]	16.67±1.20[a]	20.33±1.20[a]	17.66±5.04[a]
0. 2CD	7.67±3.18[a]	9.33±4.06[a]	11.34±4.97[a]	14.00±5.86[a]	15.33±6.69[a]	16.37±7.26[a]	17.00±7.57[a]	17.67±8.25[a]
0. 5 CD	4.33±0.33[ab]	6.67±0.33[a]	9.00±0.00[a]	11.33±0.67[a]	13.00±1.00[a]	14.67±0.88[a]	16.00±1.15[a]	18.33±1.20[a]
0. 2 CM	2.22±0.89[b]	3.33±1.33[a]	4.44±1.78[a]	5.56±2.22[a]	6.67±2.67[a]	7.78±3.11[a]	8.89±3.56[a]	9.44±3.78[a]
0. 5CM	1.78±0.62[b]	2.67±1.20[a]	4.00±1.53[a]	5.78±2.15[a]	8.00±2.52[a]	9.78±2.61[a]	11.11±2.95[a]	15.56±2.42[a]

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT)

Table 15: Effect of cow dung, manure and NPK on length of IITA-TMS-TMEB419 node

Treatment	Weeks after planting (cm)							
	9WAP	**10WAP**	**11WAP**	**12WAP**	**13WAP**	**14WAP**	**15WAP**	**16WAP**
0.2NPK	6.22±2.99^{ab}	8.00±2.52^{ab}	9.33±2.33^{ab}	10.22±2.39^{ab}	12.44±2.33^{ab}	13.78±2.66^{ab}	14.67±3.18^{ab}	16.44±3.31^{a}
0. 5 NPK	7.44±1.79^{a}	8.50±1.80^{a}	10.50±1.44^{a}	12.11±0.48^{a}	14.39±0.61^{a}	15.56±0.44^{a}	17.33±0.67^{a}	18.89±0.68^{a}
0. 2CD	3.11±0.95^{ab}	4.44±0.80^{ab}	6.22±0.97^{ab}	7.11±1.06^{ab}	8.89±1.25^{ab}	11.12±1.42^{ab}	11.56±1.56^{ab}	13.33±1.76^{a}
0. 5 CD	7.11±2.47^{a}	7.70±2.68^{ab}	8.89±3.09^{ab}	8.89±3.09^{ab}	10.07±3.51^{ab}	11.25±3.92^{ab}	11.85±4.12^{ab}	12.44±4.33^{a}
0. 2 CM	1.59±0.21^{b}	2.37±0.82^{b}	3.56±1.24^{b}	4.74±1.65^{ab}	6.518±2.27^{b}	7.11±2.47^{b}	8.29±2.89^{b}	9.48±3.30^{a}
0. 5CM	3.11±0.48^{ab}	5.33±0.67^{ab}	6.22±0.97^{ab}	7.56±0.98^{ab}	9.78±1.35^{ab}	11.55±1.44^{ab}	13.78±1.75^{ab}	16.00±1.22^{a}

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan's multiple range test (DMRT).

Table 16: Leaf area of cassava species treated with cow dung, compost manure and NPK

Treatments	Leaf (cm^2)				
	IBA0110368	**IBA980505**	**IBA30572**	**IBA070593**	**TMEB419**
0.2 NPK	2.00±0.03^{f}	49.43±0.43^{c}	63.33±0.33^{bc}	87.33±0.33^{b}	83.67±1.33^{ab}
0.5 NPK	5.00±0.57^{e}	64.33±7.17^{b}	61.00±3.21^{cd}	93.67±4.3^{b}	74.67±1.86^{bc}
0.2 CD	8.00±0.50^{d}	76.33±1.20^{a}	71.66±6.89^{ab}	66.67±2.33^{c}	84.00±.577^{ab}
0.5 CD	11.00±0.02^{c}	59.33±4.70^{bc}	74.33±1.20^{a}	90.67±0.88^{a}	94.00±1.15^{a}
0.2 CM	14.00±.51^{b}	59.30±0.65^{bc}	63.67±1.20^{bc}	86.67±0.33^{b}	85.00±4.00^{ab}
0.5CM	17.00±1.3^{a}	66.93±0.93^{ab}	51.33±0.88^{d}	81.33±0.88^{b}	60.00±2.88^{c}

Mean ± standard error followed different superscripts are significantly different at P<0.05 using Duncan multiple range test (DMRT)

Table 17: Physiological parameters of different varieties of cassava treated with different levels of manures

Treatments	Physiological parameters of five Cassava varieties														
	IBA0110368			**IBA980505**			**IBA30572**			**IBA070593**			**TMEB419**		
	LAR	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR
0.2 NPK	3950.23 ±26^{b}	0.18±.041^{b}	0.22± 0.02^{b}	4900.53 ±3.91^{ab}	0.29 ±.04^{b}	0.22± .02^{a}	4065.60± 8.22^{b}	0.29± 0.03^{b}	0.31±0 .01^{abc}	4374.56 ±2.01^{b}	0.34± 0.04^{a}	0.25± 0.11^{a}	4030.60 ±4.67^{ab}	0.170. 01^{c}	0.21±. 0.2^{b}
0.5 NPK	4020.33 ±1.74^{a}	0.24±.01^{b}	0.24± 0.03^{b}	4410.73 ±2.73^{ab}	0.29 ±.01^{b}	0.32± .03^{ab}	3853.00± 4.78^{b}	0.23± 0.04^{b}	0.36±0 .03^{ab}	4172.87 ±3.76^{b}	0.25± 0.01^{b}	0.21± 0.02^{a}	4944.93 ±3.56^{ab}	0.25± 0.04^{bc}	0.22± 0.02^{b}
0.2 CD	3993.63 ±199^{b}	0.257 ±.03^{b}	0.29± 0.02^{ab}	5814.03± 2.62^{a}	0.47 ±.02^{a}	0.39± .02^{a}	6122.31± 4.13^{a}	0.57± 0.07^{a}	0.39±0. 01^{a}	3887.70 ±1.40^{b}	0.22± 0.02^{b}	0.30± 0.11^{a}	4038.43 ±0.34^{b}	0.23± 0.34^{bc}	0.29± 0.01a^{b}
0.5 CD	4493.57 ±1.72^{a}	0.30±.015^{a}	0.37± 0.01^{a}	4694.17 ±2.70^{ab}	0.38 ±.04^{b}	0.27± .02^{ab}	4133.83± 5.47b	0.31± 0.01^{b}	0.28±0 .02^{bc}	3984.70 ±3.45^{b}	0.27± 0.04^{b}	0.34± 0.22^{a}	3805.20 ±0.03^{ab}	0.33± 0.23^{ab}	0.26± 0.20^{ab}
0.2CM	4261.70 ±3.09^{b}	0.27±.06^{b}	0.26± 0.02^{b}	4286.63 ±3.46^{ab}	0.38 ±.02^{b}	0.35±.02^{a}	4186.03b ±52.63^{b}	0.24± 0.07^{b}	0.25±0 .02^{c}	4139.97 ±2.37^{b}	0.27± 0.01^{b}	0.34± 0.03^{a}	3987.53 ±0.87^{ab}	0.33± 0.03^{ab}	0.32± 0.01a^{b}
0.5CM	3592.07 ±1.22^{b}	0.22±.02^{b}	0.28± 0.03^{ab}	3432.60 ±2.42^{b}	0.42 ±.03^{b}	0.38± .04^{a}	4094.70± 30.24^{b}	0.26± 0.05^{b}	0.29±0 .04^{abc}	5702.00 ±2.34^{a}	0.36± 0.02^{a}	0.41±0 .02^{a}	5571.90± 2.56^{a}	.37±0. 22^{a}	0.34± 0.02^{a}

Mean ± standard error followed different letters in columns are significantly different at P<0.05 using Duncan multiple range test (DMRT).

In the present study, the significant increase recorded in the agronomic characters such as lobe, internode, height and length of node of cassava varieties applied with 0.2g and 0.5g cow dung treatments connotes differential response of vegetative characters of the cassava variety to different fertilizer types or the magnitude of inherent variation for these characters influenced by different levels of the fertilizers. This observation is in agreement with reports of Adeniji *et al.* (2011),

Responses of these cassava vegetative growth parameters to organic and inorganic fertilizer varied but the fertilizers consistently enhanced the development of the parameters over the period of investigation.

Increases in the agronomic characters obtained with application of 0.5 NPK and 0.2 cow dung noticed these level of fertilizers released maximum nutrients such as N, P, K, Zn, Fe, Ca and Mg which are contained in the fertilizer for crop uptake which led to significant increases in growth parameters of the cassava.

This is because application of organic manures has been reported to have ability to have various advantages like increasing soil physical properties, water holding capacity and organic carbon content, supplying good quality of nutrients, improving soil tilt, lessens erosion, soil aeration as well as beneficial effect on soil microorganisms (Gomez *et al.*, 1980; Leo and Vernon, 2015; IITA. (2005) and Okpara *et al*. (2010).

In the same trend, Joy *et al.* (2015); Odedina *et al*., (2011) and Rammachat *et al*. (2001) also recorded significant differences in plant height, stem girth, number of leaves, branches and length of internodes/plant with the application of poultry manure levels and NPK.

The insignificant responses of cassava vegetative growth to NPK fertilizer could be due to excessive availability of nutrients which gave luxuriant top growth at expense of tuber growth (Agbaye and Akinlosotu, 2004 Leo; Mathias and Vernon Kabambe 2015).Moreover, positive influence of these treatments might be due to slow and steady availability of nutrients throughout the crop period from organic manures. Manures have been known to increase nutrient contents of cassava (Odedina *et al*., 2012). An increase in height of cassava is important to expose the cassava leaves to sunlight for photosynthesis and increased translocation for higher photosynthate accumulation (Okogun *et al*., 1999). It is interesting to note that significant differences on the parameters observed during this suggests importance of both fertility amendments in improving crop growth (Lebot, 2009). Tolessa (2001) reported that after 120 DAP, the leaves are able to intercept most of the radiation falling on the canopy and it is the time when the maximum size of the canopy with the maximum dry matter partition of the leaves and stems are obtained. Howeler (1990) further stated that large bulk of foliage are created by the action of nitrogen and consequently an extensive assimilating area, a prerequisite for the good development of the tubers. According to Uwah *et al.* (2009) plant height, the number of leaves, branches as well as stem girth was significantly increased by the application of NPK. Various research findings showed superior growth attributes obtained with relatively high rates of NPK (NRCRI, 2005). The positive response of growth characters to the applied nutrients is attributable to their role in cell multiplication and photosynthesis which gave rise to increase in size and length of leaves and stems. The favourable response also confirmed the essentiality of N and K in plant growth and development (Mengel and Kirkby, 2001). This result is in harmony with the findings of Nguyen *et al*. (2001) and Ayoola and Makinde (2007).

Nutrient supplied by cow dung manure enhances increase in plant height due to increase in cell elongation of plant tissues as a result of steady release and mineralization of nutrients Christopher *et al*., 2007). Adoa (2009) reported highest plant height with the application of poultry manure on *Nkabom* and IFAD cassava varieties. The height may position or expose the leaves of the cassava to sunlight for photosynthesis and increased translocation for higher photosynthates accumulation. This agreed with the submission of Ojeniyi *et al*. (2012).

Organic fertilizer promote the growth of stems and leaves of cassava, increase the chlorophyll content and the photosynthesis of leaves and improve the physiological metabolism of cassava (Luo *et al.*, 2005). Luo *et al.*, (2005) added that organic fertilizer improves the physiological metabolism of cassava and also promote the photosynthetic transfer to the root and increase number of root, yield and starch content in the tuber root of cassava.

Leaf area increased with increase in the levels of organic manure and the increase was linear. Highest value of leaf area obtained in IITA-TMS-TMEB419 applied with 0.5g cow dung suggests that cow dung at 0.5g enhanced proper development of leaf area of the cassava variety. Also, observation could have resulted in high biomass production due to increase in the level of nitrogen and other mineral elements in the high rate in cow dung. This finding is in agreement with submission of Joy *et al.,* 2017 which highlighted the influence of nitrogen on, crop growth rate and net assimilation rate of cassava. According to Makinde and Ayoola (2010) plant leaf areas from sole organic and complementary application of organic and inorganic fertilizers were similar with sole inorganic fertilizer application. Also, higher leaf area recorded has been reported to be helpful for formation of canopy which account for higher nutritional content recorded in plants because large surface area has been reported to contain higher pigment which enhanced better photosynthetic activities. This observation is in line with findings of Niels (2005) who reported that Canopy models can contribute to capture light for photosynthesis.

Highest relative growth rate and leaf area ration recorded in IITA-TMS-IBA30572 treated with 0.2g cow dung and net assimilation rate in IITA-TMS-IBA070593 treated with 0.5g cow dung may indicate varietal responses of the cassava to the fertilizer types investigated.

Significantly values of leaf area ratio, relative growth rate and net assimilation rate recorded have been used to evaluate leaf efficiency in photosynthesis (Mofit *et al.,* 2011; KUAI *et al.,* 2017). Similarly, this observation has been related to the ability of cassava performance on photosynthesis process. The net assimilation rate reflects the capacity to synthesize biomass and the relative growth rate reflects whether the allocation of biomass and its transfer to different organs during various growth stages is smooth and whether the source–sink balance is optimal. This may suggest role of the fertilizer at various levels influence the biomass and their distribution. According to Gomathinayagam *et al*. (2007), net assimilation rate and the relative growth rate directly affect the accumulation of biomass and its distribution. The relative growth rate is affected by the net assimilation rate. Generally speaking, the higher the net assimilation rate, the higher the relative growth rate (Ruiz-Robleto and Villar 2005; Sharma *et al*. 2007).

Cow dung at 0.2 and 0.5 g significantly increased leaf area ratio and net assimilation rate during the seedling stage and the bud stage as well as the relative growth rates of leaves and roots, promoting the accumulation of biomass in leaves and roots during the corresponding growth stages.

Earlier studies have also shown that paclobutrazol makes leaves thicker, darker green (as a result of higher chlorophyll content), and larger (greater specific leaf area); these changes effectively promote photosynthesis (Tekalign and Hammes, 2005), root growth, and vigour.

The importance of leaf area in relation to basic plant metabolic processes, such as photosynthesis and respiration, is generally recognized

Cassava is consumed in various forms by a large percentage of the populace. Its production has increased considerably in recent years, as a direct result of the importance of the crop as an industrial crop in natural starch manufacture, brewery. It is also due to its significance as a staple food crop that is eaten in various forms such as fufu, gari and tapioca among others based on its rich proximate contents (Agyenim-Boateng and Boadi, 2007). According to Adoa (2009), local farmers over the years have been using root dry matter as an index for cultivating particular cassava varieties that suit their food needs.

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