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Performance of Two Cassava (*Manihot Escculenta* Crantz) Genotypes to NPK Fertilizer in Ultisols of Sikasso Region, Mali

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Abstract

In Mali, cassava is grown on ultisols in Sikasso region situated in the southern part of the country. The yields are however low due to the low fertility of the cassava growing soils, inadequate fertilizer use and low yielding genotypes. This study aimed at determining the effect of four NPK fertilizer (15-15-15) rates (0 kg ha^{-1}, 100 kg ha^{-1}, 200 kg ha^{-1} and 300 kg ha^{-1}) applications on growth and yield of two cassava genotypes. A randomized complete block design (RCBD) with three replicates was used in two sites during 2016/2017 cropping season. The fertilizer rates were applied in two splits of equal quantity at two weeks after planting and two months later. Data on plant height, numbers of branches, number of stem, stem diameter, number of tubers per plant, and fresh tuber weight were collected. Data collected were subjected to analysis of variance using Statistical Analysis System (SAS version 9.3). Least Significant Difference (LSD) at p=0.05 was used to separate means. The 300 kg ha^{-1} of NPK did achieve a significant output on both growth and yield parameters compare to the other rates. The number of tuber per plant and fresh tuber yield increased by 49% and 133% respectively in the plot which received 300 kg ha^{-1} of NPK compared to the controls. There was a significant correlation (r=0.6533 at P =0.0005) between the NPK fertilizer rates and fresh tuber yield in Loulouni. The results will form a basis for NPK use on cassava in the study area and policy briefs in the country.

Keywords: Cassava; Correlation; NPK inorganic fertilizer; Southern Mali; yield.

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1. Introduction

Cassava is a major staple food crop in most parts of Africa and plays an important role in food security, employment and income generation for farm families in humid tropics [31]. It is one of the most consumed root crops in the world and second important staple food for energy in Sub-Saharan Africa [7]. Despite the importance of cassava in these regions its low productivity remains a major concern. The production of cassava in many region in Africa is limited by soil fertility, diseases, unfavorable agro-climatic conditions and low yielding varieties [8,25]. Productivity can be therefore being increased through soil fertility enhancement by use of manures and inorganic fertilizers. The use of inorganic fertilizers has been shown to significantly increase cassava yield in low fertility soils of West Africa [5]. For sustainable production, nutrient replenishment forms an important component in cassava production. For example, one hectare of cassava require an annual applications of 50 to 100 kg of nitrogen, 65 to 80 kg of potassium and 10 to 20 kg of phosphorus, depending on the soil's native fertility and the desired yield objective [14]. An NPK combined complexes fertilizer use is more benefic on cassava yield than when applied from separate source as shown in [21] in which study a combined NPK (15-15-15) inorganic fertilizer of 400 kg ha^{-1} gave a yield of 7.90 t ha^{-1} higher than the yield obtained from the application of N, P, K from single fertilizer source of urea, single superphosphate and muriate of potash respectively. An extensive review of fertilizer trials on the response of many cassava varieties underpins the importance of inorganic fertilizer in cassava production in the low fertility soils of Africa [18]. The importance of cassava in the different Sahelian countries in West Africa is varied as indicated by the annual production in Tchad, Senegal, Niger, Mali and Burkina Faso of 250,000, 154,071, 150,000, 38,000 and 4,350 tons in 2013, respectively [4]. The Collaborative Study on Cassava in Africa (COSCA) in early 1991 stated the cassava average yield in Africa to be 11.9 t ha^{-1} although some media cassava producer's countries in West Africa registered higher yield; Yield of 14.7 t and 13.1 t ha^{-1} were respectively obtained from Nigeria and Ghana [16]. The average national cassava yield in Mali is 16.5 t ha^{-1}. The average yield among the cassava growing regions, however, do not vary much; between 2007 and 2011 the average were 15.5 t ha^{-1} in Sikasso, 17.8 t ha^{-1} in Mopti and 16.2 t ha^{-1} in Timbuktu region [10]. Although the cassava growing soils of Mali have low fertility, no specific study has been done to establish the suitable rates of NPK application on cassava in the country. In 2011 a diagnostic study recommended a study on inorganic fertilizer use on cassava across the country [10]. In Mali, cassava is grown with inadequate inorganic fertilizer rate application leading to the low yield. This is mainly due to high cost and the unavailability of fertilizer recommendation rates. The aim of this study is therefore to generate information on cassava performance with inorganic fertilizer application under two cassava genotypes in the ultisols of Sikasso. The results of this study will provide indicative rates of inorganic NPK (15-15-15) fertilizer application for cassava production.

2. Material and methods

2.1 Experimental site

The experiments were conducted in two sites located in important cassava growing area of the wider Sikasso administrative region in southern Mali. The first site is located in Loulouni (10°54'0'' N and 5°36'0'' W) *commune* in Kadiolo District. Its altitude is 455 meters above sea level. The average annual rainfall is 1,200 mm and extends from May/June to October/November while the dry season sets in from November to May. The average annual temperature ranges between 21 to 32°C [28,23]. The predominant soils in Louluni are classified as ultisols [15]. Cotton, rice, maize, sorghum, groundnut, millet, sweet potato, potato, cassava, and yam are the main crops grown in the zone. The second site located at the Institut d'Economie Rurale (IER) research station (11° 5'59'' N and 5°30'49'' W) in Finkolo rural *commune* of Sikasso District. Finkolo *commune* is located at an altitude of 330 meters above sea level. The average annual rainfall is 1,100 mm and its distribution is similar to Loulouni's. The annual average temperature ranges between 24 and 32°C. The predominant soils are classified as Ultisols [15]. The major crops grown in the zone are yam, maize, sorghum, groundnut, millet, sweet potato, potato, fonio, rice, and cassava.

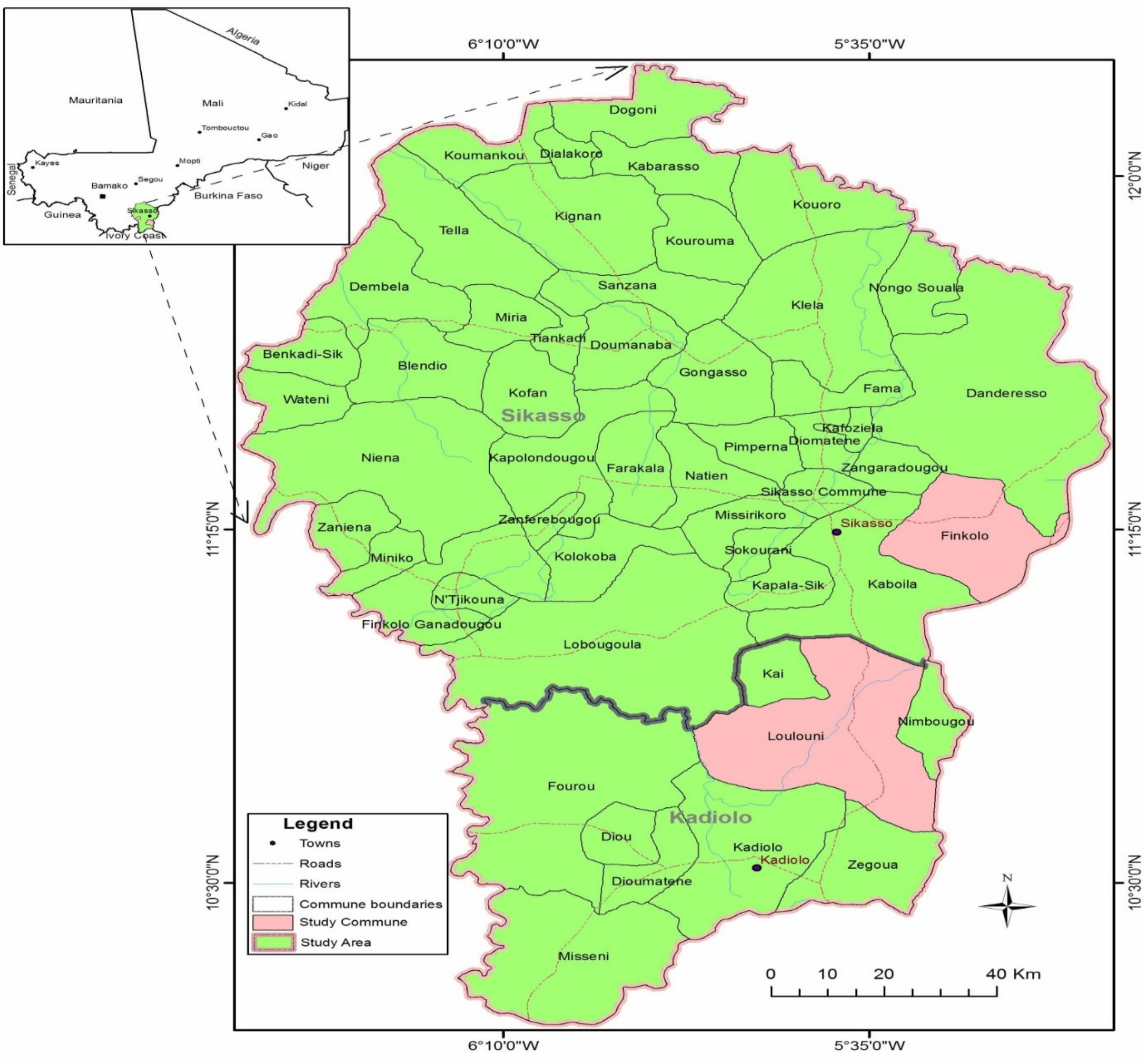

Figure 1: Map of experimental sites

Source: Adapted from Ethiopian Mapping Agency, by Geoffry Maina environmental science Egerton University 2016.

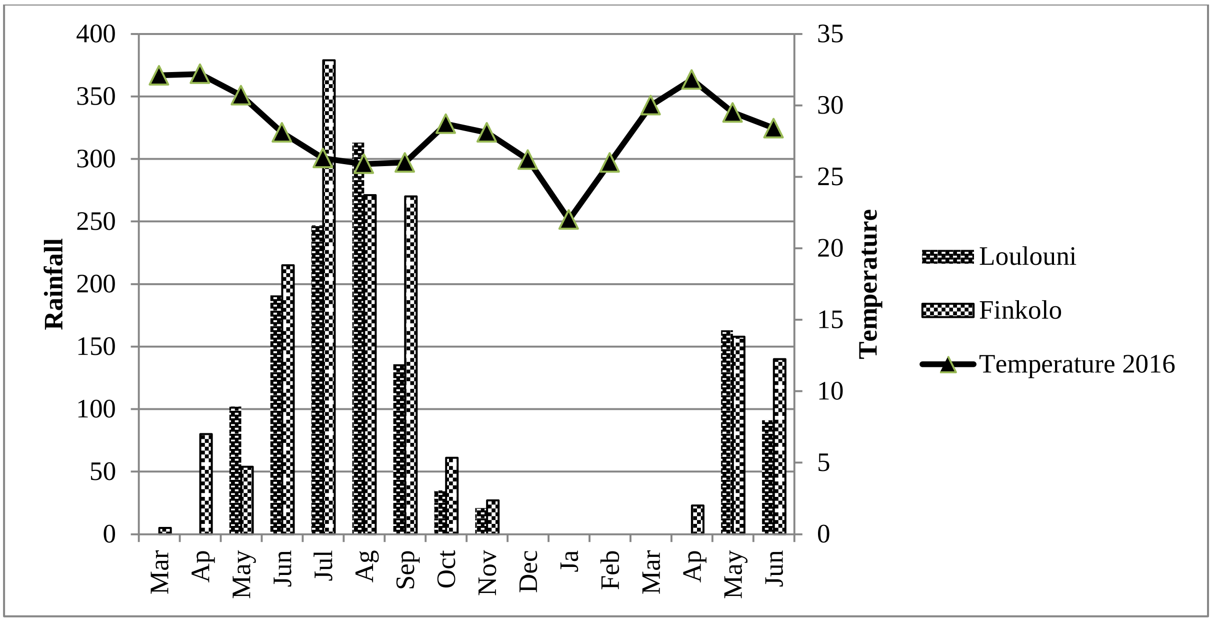

Figure 2: Rainfall and mean temperature in the study areas

Source: IER Finkolo/Farako Research Station and Météo/Mali-Sikasso (2016-2017)

2.2 Experimental design and field layout

The experiments were set up in a randomized complete block design (RCBD) with three replications. The study involved two factors: two cassava genotypes and four NPK (15-15-15) fertilizer rates. The two genotypes used were *Bonima*, a local genotype widely grown in the region, and *Sika*, an improved drought and disease tolerant genotype from Ghana. The local genotype, *Bonima* was obtained from the farmers whereas the improved genotype was supplied by IER. The four NPK fertilizer rates were; 0 Kg NPK, 100 Kg NPK (equivalent of 15kg N ha^{-1}, 15kg P ha^{-1}and 15kg K ha^{-1}), 200kg NPK (same as 30kg N ha^{-1}, 30kg P ha^{-1}and 30 kg K ha^{-1}) and 300 Kg NPK (equal to 45 kg N ha^{-1}, 45kg P ha^{-1}, and 45 kg K ha^{-1}). The plot sizes were of dimension 4 m x 5 m with 1 m alleys between plots and two meters between replications.

2.3 Experimental procedure and management

The land was cleared of weeds and prepared for planting using hand implements. The seed beds were made into ridges of 4 m long and 1 m from each other. Cassava planting materials were cut into 20 cm long pieces and planted horizontally in the ridges by placing the two-thirds of the cutting in a hill and planted at a spacing of 1 m within a row and 1 m between rows. The fertilizer was applied by placing the respective amount of the NPK fertilizer treatment beside each planting hill technique shown to increase the nutrient use efficiency [6]. The application was done in two equal splits, the first at two weeks after planting and the second two months later. The cuttings were treated with fungicide before planting to prevent possible fungal attack. Weeding was done two weeks after planting and repeated as needed. During the trial, termite attack was observed in Finkolo site and Feradan (Cabofuran or $C_{12}H_{15}NO_3$) was used to control its damage in the trial. The cassava trial was planted on first and second October 2016 in Loulouni and Finkolo respectively. The harvesting was done at the end of

June month in 2017, 9 months after panting.

2.4 Soil sampling and analysis

Samples from topsoil (0-20) and subsoil (20- 40) from each experimental site (Loulouni and Finkolo) were collected for soil characterization. Soil texture was determined using the hydrometer method [20]. Analysis of pH was measured in H_2O (soil water ratio of 1: 2.5) using a pH meter, exchangeable bases K^+, Ca^{2+}, Mg^{2+}, Na^+, Cation Exchange Capacity (CEC) were extracted with ammonium acetate solution and analyzed using a Flame Photometer, total nitrogen using the Kjeldahl method, available Phosphorus and soluble Potassium was extracted using Mehlich extractant and analysed using colorimetric spectrometry and flame spectrophotometry, respectively, and organic carbon was analyzed using the Walkley-Black wet-oxidation method [20].

2.5 Cassava growth and yields parameters

Plant growth and performance indicators in form of plant height, numbers of branches, number of stems, stem diameter, number of tubers by plant, and fresh tuber yield were measured. The measurements of plant growth were taken on six plants in the net-plot of each treatment at 4, 6, and 8 month after planting (MAP). The selected cassava plants were tagged for the indicated measurements. The plant height was measured from the stem part above soil up to the tallest branch of the plant. The numbers of branches were counted on those attached directly to the main stem. Stem from the cutting was also counted. Stem diameter was taken at two cm above the soil. The tuber yield was taken at nine months after planting from the six plants and expressed in a number of tubers per plant and in kg ha^{-1} of fresh tubers.

2.6 Data analysis

The data was subjected to analysis of variance and the means separated using Least Significant Difference (LSD) at $p<0.05$. Correlation between fertilizer rates and the different growth and yield parameters were done using Pearson Coefficient.

2.7 Experimental model

The model of the experiment is given below.

Genotypes = 2; Locations = 2; Fertilizer rates= 4; Replications = 3

$$Y_{(ijklm)} = \mu + L_i + \beta_{j\,(i)} + G_k + LG_{ik} + F_l + LF_{il} + GF_{kl} + \varepsilon_{ijklm}$$

Where:

μ = Overall means

L_i = Effect of the i^{th} location

$Bj_{(i)}$ = Effect of the j[th] blocking in i[th] location

G_k = Effect of k[th] genotype

LG_{ik} = Interaction effect between i[th] location and k[th] genotype

F_l = Effect of l[th] fertilizations

LF_{il} = interaction effect between i[th] location and l[th] fertilization

GF_{kl} = Interaction effect between k[th] genotype and l[th] fertilization

ε_{ijklm} = Random component error.

3. Results

3.1 Soil characteristics

The soils in the two sites are classified as sandy loamy texture, low in organic carbon and slightly acidic (Table 1). The cation exchange capacity (CEC) of the soils were low but had moderate levels of exchangeable bases. The soils had low nitrogen level and very low of phosphorus content. The soil from the both study sites had low natural fertility status with respect to cassava nutritional needs [19].

Table 1: Chemical and physical properties of top and subsoil of experimental site

	Loulouni site		**Finkolo site**	
	Depth			
Parameters	0-20 cm	20-40 cm	0-20 cm	20-40 cm
pH(H_2O)	5.78	5.79	5.80	5.81
Organic carbon (% C)	0.64	0.43	0.55	0.42
Available phosphorus (ppm)	1.28	0.83	7.41	---
Total Nitrogen %N	0.03	0.01	0.02	0.01
CEC meq/100g	4.32	3.11	3.07	2.92
Ca exchangeable (mg/Kg)	334	194	194	176
Mg exchangeable (mg/Kg)	100.8	57.6	58.8	51.6
K exchangeable (mg/Kg)	117	58.5	35	35
Na exchangeable (mg/Kg)	1.32	1.32	1.32	1.32
Sand %	63	75	58	67
Silt %	33	23	40	31
Clay %	4	2	2	2
Textural class	Sandy loam	Sandy loam	loam	Sandy loam

3.2 Effect of NPK fertilizer, genotype, and site on cassava growth parameters

The effect of NPK fertilizer on cassava height is presented in Figure 3. The cassava plants heights were significantly ($p<0.05$) increased by NPK inorganic fertilizer application. Cassava plant receiving 300 kg $ha^{-1}$of NPK had significantly taller plants than plots receiving 0 and 100 kg ha^{-1} of NPK but similar to the plots receiving 200 kg ha^{-1}. These differences were observed only at 8 MAP where the highest rate of application at 300 kg ha^{-1} of NPK had 27 to 29% higher plant than 0 and 100 kg ha^{-1} of NPK. The height of 126 cm from 300 kg ha^{-1} of NPK application was found to be significantly different from the height of 0 and 100 kg $ha^{-1}$of NPK applied. However the 126 cm was significantly different from the height gotten by the application of 200 kg ha^{-1} of NPK.

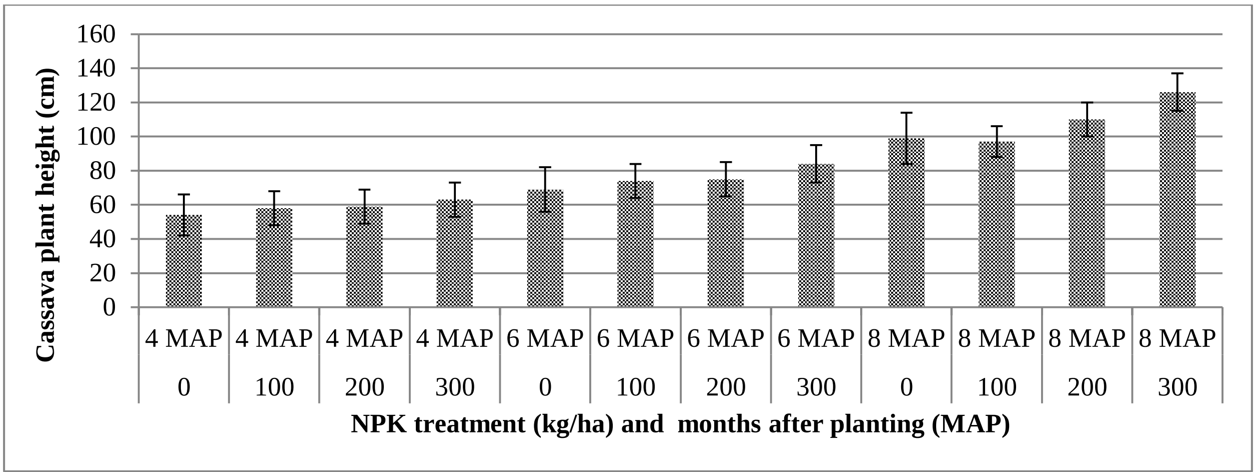

Figure 3: Effect of NPK doses on cassava mean height

The cassava plant heights of the two genotypes were found to be significantly different at all observation times as presented in Figure 4. *Bonima* genotype had significantly ($p<0.05$) taller plants than *Sika* at 4, 6 and 8 MAP. *Bonima* genotype achieved a height of 78, 99 and 136 cm at 4, 6 and 8 MAP respectively; while *Sika* got 33, 52 and 80 cm at 4, 6 and 8 MAP respectively. *Bonima* growth rate in height was 74% between 4 and 8 MAP; while *Sika* recorded 143 % during the same time.

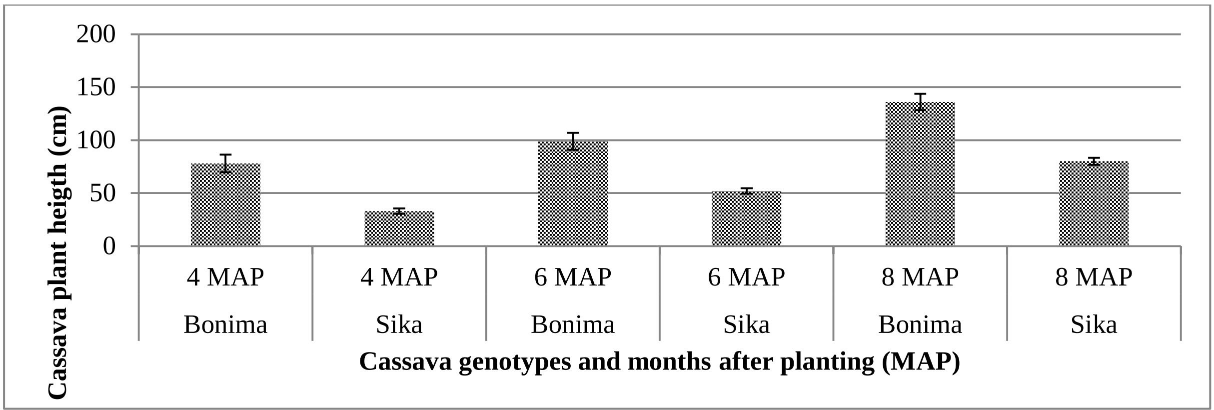

Figure 4: Effect of cassava genotype on mean plant height

On cassava plant height, only the site by genotype interaction effect was found to be significant among site by level of fertilizer and genotype by level of fertilizer interactions (Table 2). *Bonima* and *Sika* had higher plant heights in Loulouni than Finkolo during the observation times.

Table 2: Effect of site by genotype interaction on cassava mean height

Sites	MAP	**Cassava mean height (cm)**	
		Bonima	**Sika**
Finkolo	4	39.67^{A}	28.92^{B}
	6	63.67^{A}	46.75^{B}
	8	113.25^{A}	82.33^{B}
Loulouni	4	115.75^{A}	49.75^{B}
	6	134.33^{A}	57.67^{B}
	8	160^{A}	78^{B}

Means followed by the same letter in rows are not significantly different at p=0.05

MAP: Months after planting

This height differences were attributed to the higher natural soil fertility in Loulouni than Finkolo (Table 1).

Cassava stem numbers were not significantly affected neither by NPK fertilizer nor by genotype. Moreover, for interaction effect, the stem number among the three interactions studied namely site by level of fertilizer, genotype by level of fertilizer and site by genotype interaction, only site by genotype interaction was found to be significant from 4 to 8 MAP as presented in Figure 5.

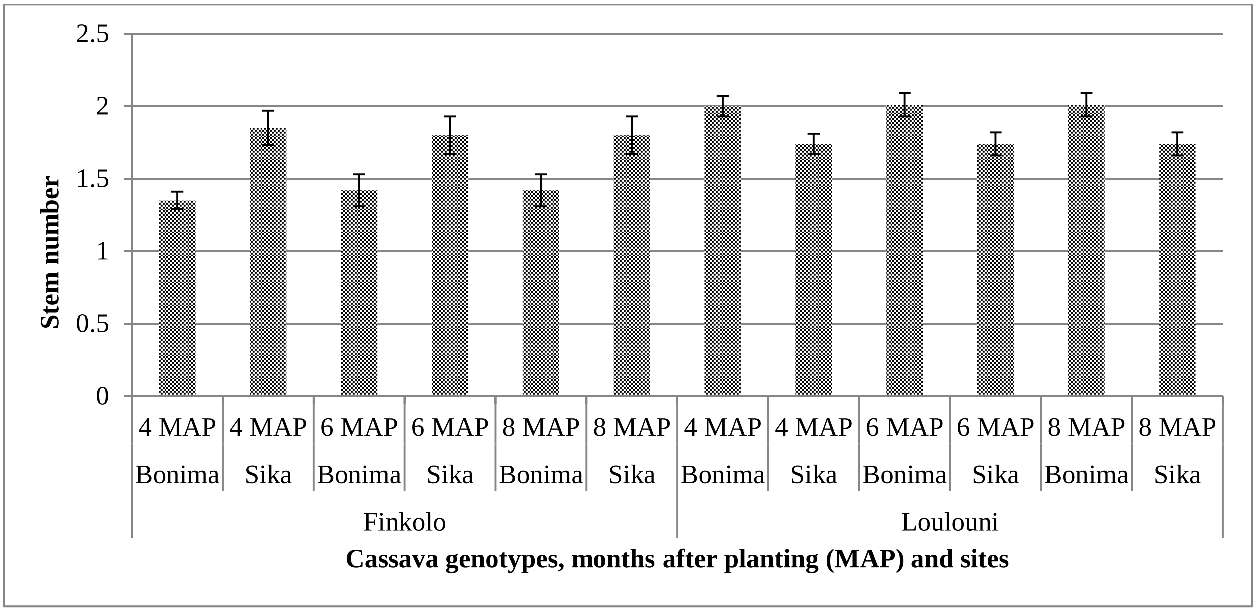

Figure 5: Effect of site by genotype interaction on cassava stem mean number

The number of stems of *Sika* and *Bonima* genotypes was constant in each site from 4 to 8 MAP. But its number in Loulouni was significantly higher from the ones in Finkolo for the two genotypes during the observation times.

The number of branches per plant was significantly affected by NPK fertilizer at 6 and 8 MAP (Figure 6). At 6 and 8 MAP the highest NPK rate of 300 kg ha^{-1} had an average of 2.05 branches per plant which was significantly different from the number of branches gotten by 0, 100 and 200 kg ha^{-1} of NPK respectively.

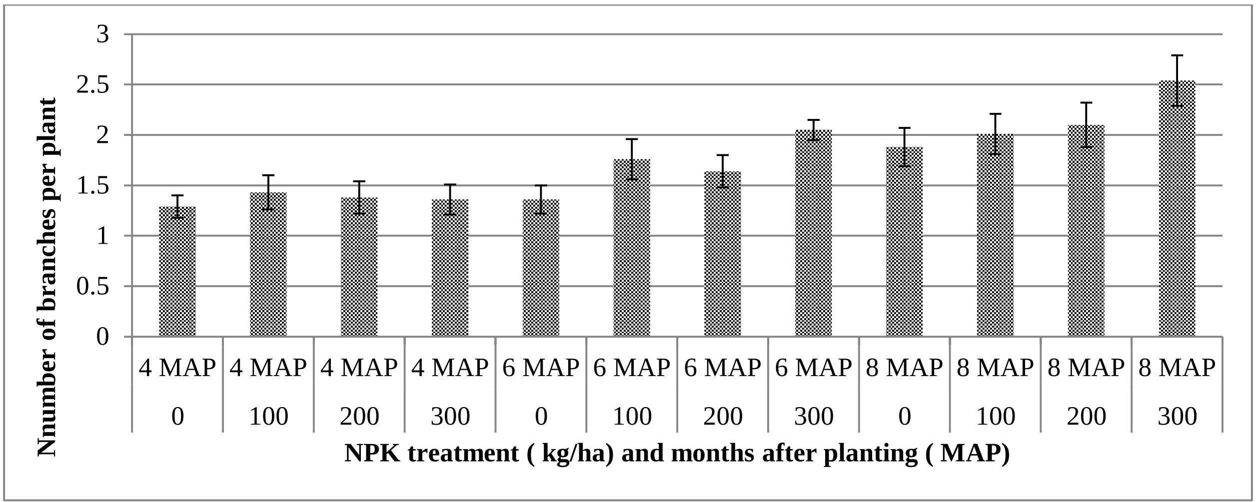

Figure 6: Effect of NPK fertilizer doses on the mean number of branches per plant in cassava

The numbers of branches per plant were significantly affected by the cassava genotype (Figure 7). The mean number of branches of the two cassava genotypes had increased from 1.09 to 1.65 for *Bonima* and from 1.34 to 2.06 for *Sika* respectively, during the periods of 4 to 8 MAP. From 6 to 8 MAP the number of branches remained constant.

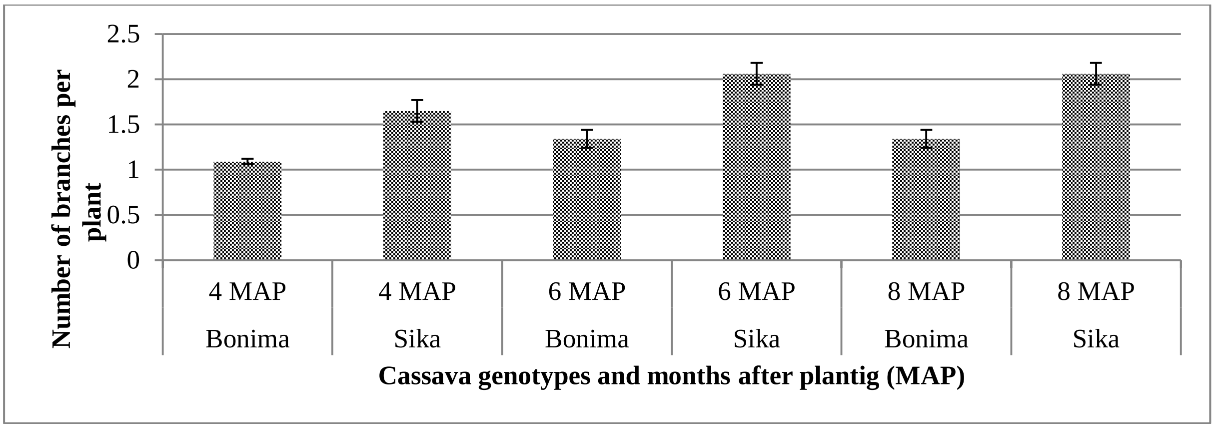

Figure 7: Effect of genotype on mean number of branches in cassava

The number of branches per plant was found to be significantly affected only by the site by genotype interaction at 4 MAP (Figure 8).

The differences in cassava plant number of branches are effective at 4 MAP. In Loulouni, the number of branches per plant at all-time for *Sika* genotype was found to be similar but was significantly different from *Bonima's*. The *Bonima* genotype itself did not show a significant difference during the observation times. In Finkolo, *Sika* genotype number of branches at 6 and 8 MAP were similar but different from the one at 4 MAP. The same trend for *Bonima* genotype was observed.

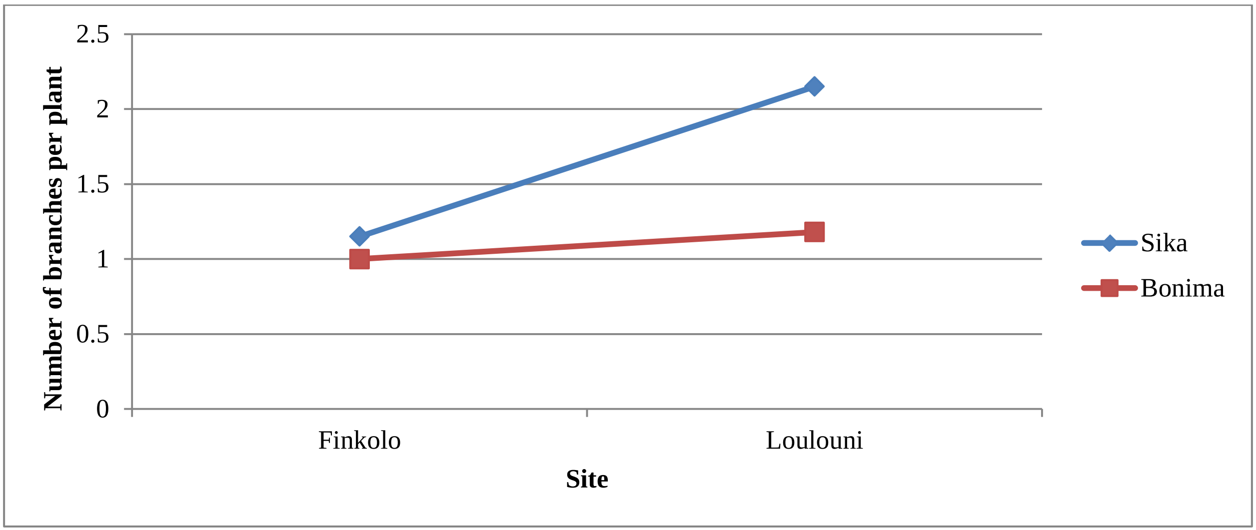

Figure 8: Effect of site by genotype interaction on cassava mean number of branches

Cassava stem diameter was found to be significantly affected by NPK fertilizer only at 8 MAP (Fig. 9). The stem diameter from the application of the two higher rates of 200 and 300 kg ha^{-1} of NPK was not significantly different, but significantly differed from stems obtained by the application of 100 kg ha^{-1} of NPK and the control. The stem diameter of cassava plants which received 200 and 300 kg ha^{-1} of NPK was 6.68 cm and 6.12 cm respectively. The treatment applied with 300 kg ha^{-1} of NPK had at 8 MAP increased cassava stem diameter by 25% compared to the control. However, cassava stem diameter was found not to be significantly affected by genotype as well as site by level of fertilizer, genotype by level of fertilizer and site by genotype interactions.

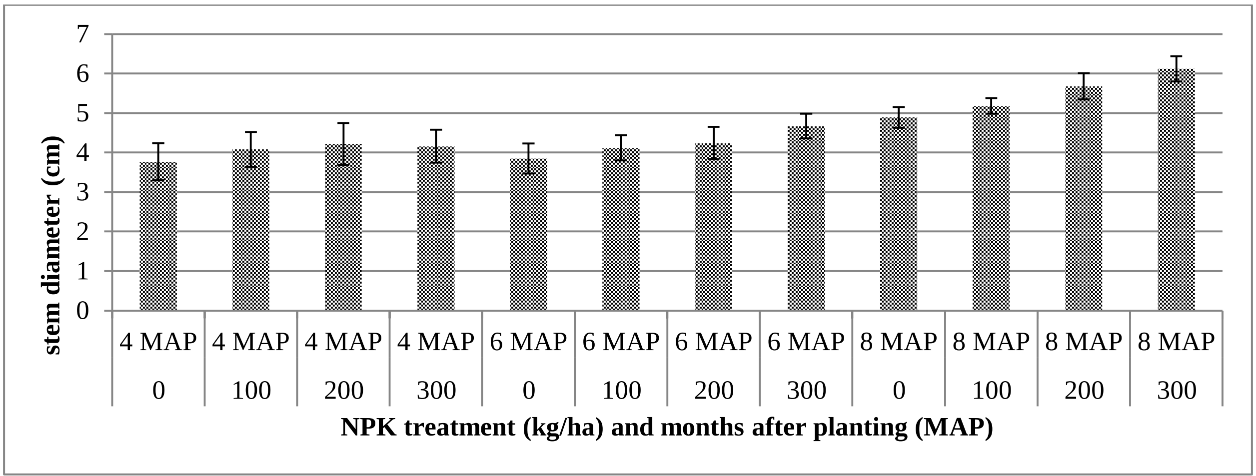

Figure 9: Effect of NPK fertilizer on cassava mean stem diameter

3.3 Effect of NPK fertilizer, genotype, and site on cassava yield

The number of tuber per plant was found to be significantly affected by NPK fertilizer (Figure 10).

The numbers of tubers for the two highest NPK applications were similar but significantly higher by up to 49% compared to the control and the 100 kg of NPK per $ha^{-1}$of plots.

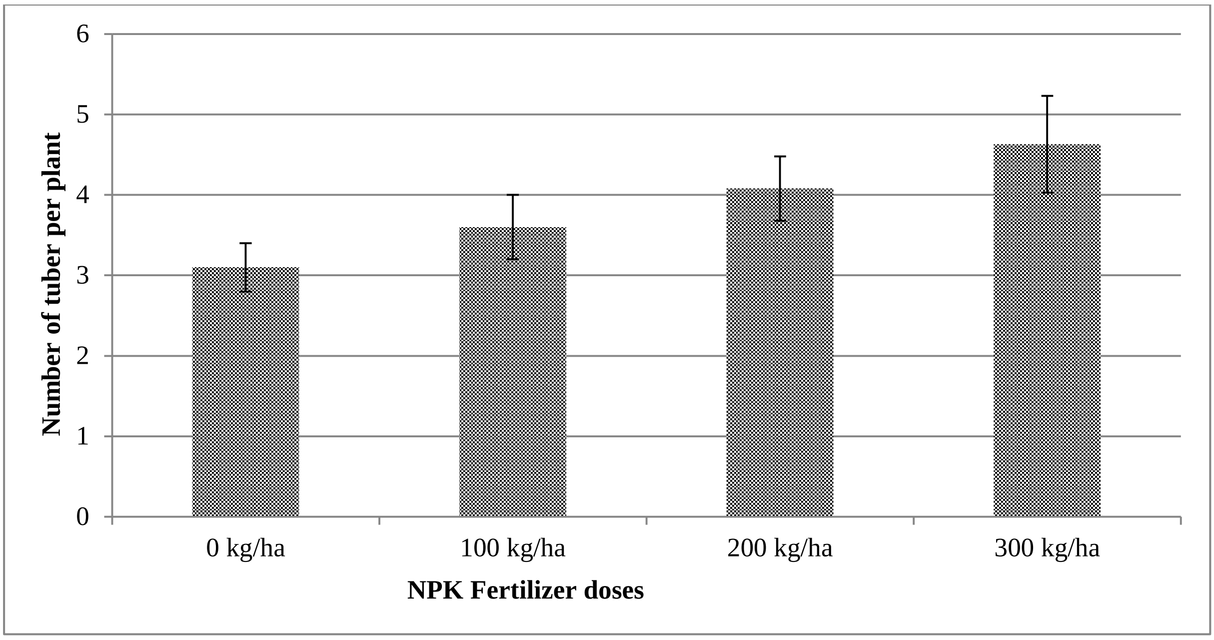

Figure 10: Effect of NPK fertilizer on mean number of cassava tubers per plant

The number of tubers per plant was significantly affected at harvest by the genotype (Figure 11).

The *Sika* genotype had 4.9 tubers per plant which were 75% higher than *Bonima's* which had 2.8 tubers per plant.

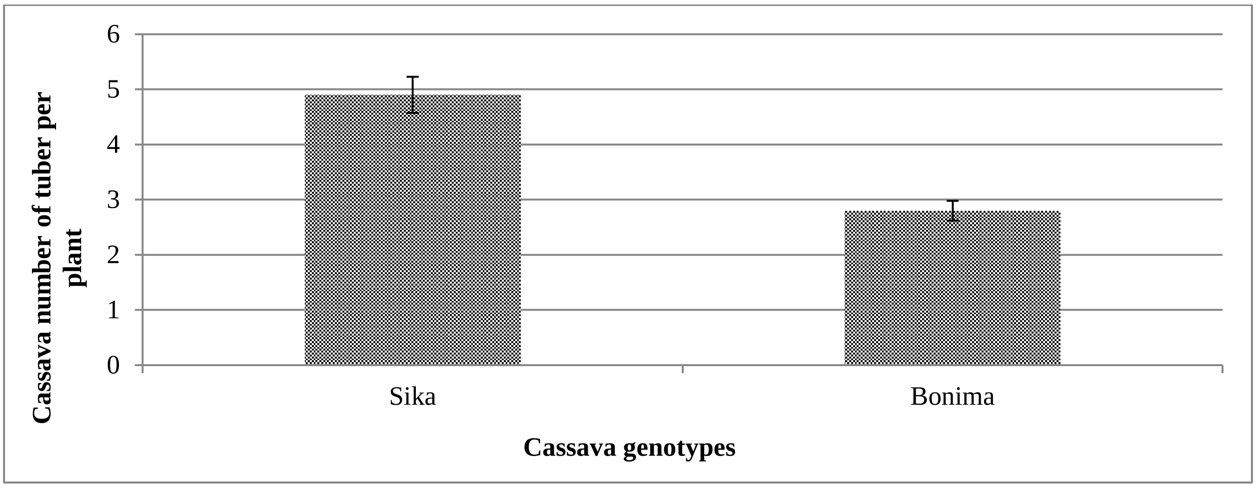

Figure 11: Effect of genotype on cassava mean number of tubers per plant

The application of NPK fertilizer was found to significantly increase cassava fresh tuber yield (Figure 12). The 300 kg ha^{-1} of NPK had increased the yield by 133%, 44% and 42% compared to the control, 100 kg ha^{-1} and 200 kg ha^{-1} of NPK, respectively. Similar to number of tuber by plant, cassava fresh tuber yield also was found to be significantly affected by genotype. *Sika* genotype produced a yield of 8378 kg ha^{-1} which was 76% higher than the yield obtained by *Bonima* genotype (4753 kg ha^{-1}).

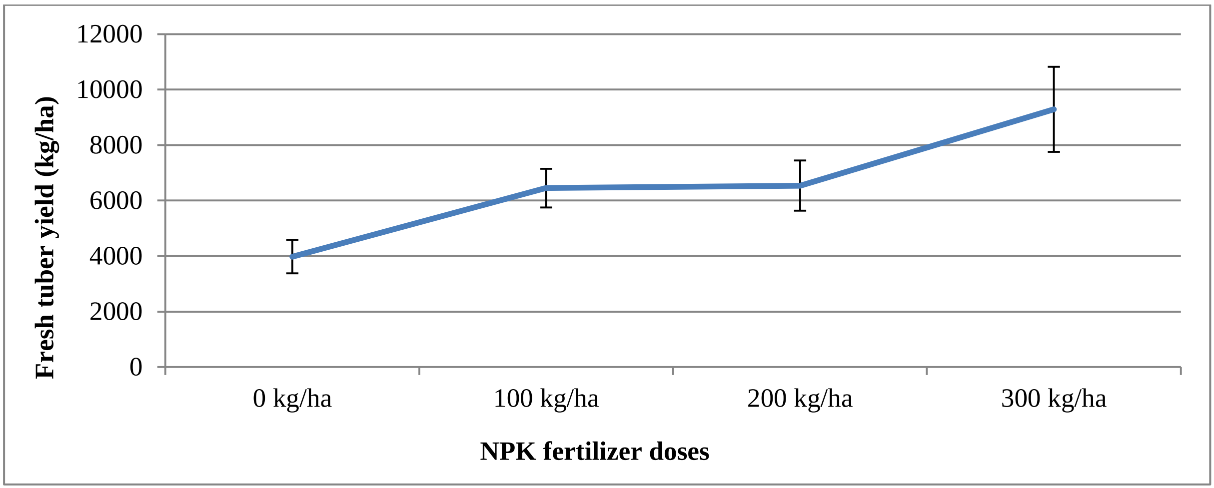

Figure 12: Effect of NPK fertilizer on mean cassava fresh tuber yield

The cassava fresh tuber yield was significantly affected only by site by level of fertilizer interaction (Figure 13). The application of 300 kg ha^{-1} of NPK allowed 112% and 163% yield higher in Loulouni and Finkolo respectively compared to the control.

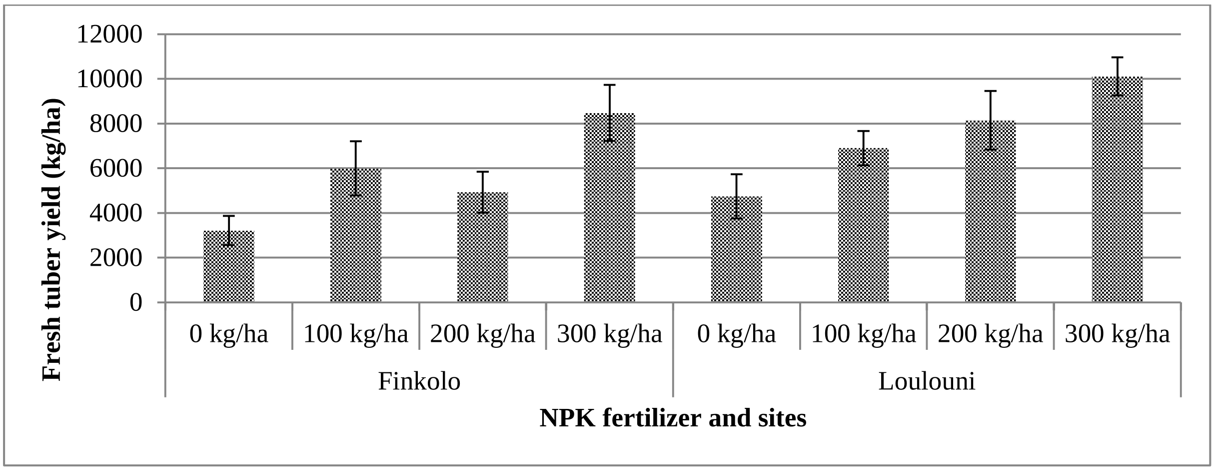

Figure 13: Interaction effect of site by NPK fertilizer on cassava mean fresh tuber yield

3.4 Correlation of cassava growth and yield parameters

The Pearson correlation coefficient analysis was use and shown in Tables 3 and 4 for Loulouni and Finkolo respectively. The number of tuber per plant and number of branches per plant are correlated in both sites. The fresh tuber yield and NPK level are positively correlated in Loulouni but not in Finkolo.. In Loulouni and

Finkolo Fresh tuber yield and stem diameter are not correlated. Stem diameter and plant height are not correlated in Loulouni. Cassava stem diameter and number of branches are correlated only in Loulouni site. Cassava plant height and number of branches are negatively correlated in Finkolo and positively in Loulouni.

Table 3: Correlation of cassava growth parameters and yield in Loulouni

	NPK level	Plant height	Branch numbers	Stem diameter	Number of tubers/plant	Fresh tuber yield
NPK level	1.00000					
Plant height	0.0554ns	1.00000				
Branch numbers	0.2060ns	0.6681**	1.00000			
Stem diameter	0.2328ns	-0.0118ns	0.5670**	1.00000		
Number of tubers/plant	0.4854*	-0.4135*	0.7167 ***	0.5689**	1.00000	
Fresh tuber yield	0.6533**	-0.4030*	0.6076**	0.3306ns	0.7180***	1.00000

Ns: not significant; *Significant at p=0.05; ** significant at p=0.01; *** Significant at p=0.001

Table 4: Correlation of cassava growth parameters and yield in Finkolo

	NPK level	Plant height	Branch numbers	Stem diameter	Number of tubers/plant	Fresh tuber yield
NPK level	1.00000					
Plant height	0.3360ns	1.00000				
Branch numbers	0.2060ns	-0.4848*	1.00000			
Stem diameter	0.3440ns	0.6146**	0.0332ns	1.00000		
Number of tubers/plant	0.2144ns	-0.323ns	0.5829**	0.1571ns	1.00000	
Fresh tuber yield	0.3800ns	-0.0695ns	0.6422**	0.3231ns	0.3380ns	1.00000

Ns: not significant; *Significant at p=0.05; ** significant at p=0.01; *** Significant at p=0.001

4. Discussion

4.1 Growth parameters

The results on cassava plant height showed that cassava plants responded well to high level of NPK (300 kg ha^{-1}) application at the middle stages of growth (8 MAP). This means that to obtain higher cassava growth high NPK rates are necessary. Environmental conditions had an effect on plant growth (rooting) which made the plant able to benefit from the second split application of NPK. These findings are in agreement with those mentioned [30] in Indonesia who showed that the growth of cassava was positively affected by the application rate of fertilizer. It is demonstrated that increasing dose of chemical fertilizer increased cassava plant height [11]. The difference in height and the growth rate is attributed to the genotype characteristic. This means that *Bonima* was able to achieve greater height with the same resources when compared to *Sika.*

The number of stem benefited from the favorable environmental conditions in Loulouni site at the early growth stage which was responsible for the increase of cassava plant stem numbers in that site. Moreover the interaction site by genotype had affected the stems number confirming finding in Brazil shown by [1] in which stem number increases was attributed to characteristics on cassava cultivar, cultural practices, and climatic conditions. Therefore, the same author confirms that cassava cultivar having strong apical dominance develops only one stem.

For the number of branches per plant, the higher rate of fertilizer meant higher nutrient uptake and more benefic for the plant. The finding is similar to the one observed in [22] study in Malawi it is shown a significant effect of inorganic fertilizer on cassava number of branches per plant.

The genotype effect on cassava branching agrees with a previous finding by [2] in South Africa which showed that cassava crop branching characteristics are affected by the genotype. A higher number of branches per plant are important to expose the cassava leaves to sunlight for photosynthesis and increased translocation for more photosynthate accumulation [26].

The environmental conditions had an effect on the number of branches per plant through a positive interaction between site and genotype. Nevertheless, *Sika* genotype was more responsive to environmental changes with respect to number of branches per plant.

The increase in stem diameter may be attributed to the more nutrient availability with high NPK inorganic fertilizer rate, especially from the second split application. This study is consistent with findings in Nigeria in which cassava stem diameter was found to significantly increase as the N and K rates were increased [31].

4.2 Yield parameters

The results on cassava number of tuber per plant seem to indicate that application of NPK below 200 kg ha^{-1} does not supply enough nutrients to support higher tuber numbers. The study showed an increasing number of tubers per plant with a higher rate of NPK inorganic fertilizer. The finding is in agreement with a previous study in Kenya and Uganda, which found that the application of 100, 50 and 100 kg ha^{-1} of N, P and K inorganic fertilizer respectively resulted in an increase in a number of storage roots per plant [17]. In Malawi, the same trend was observed by [22] when they showed a significant inorganic fertilizer effect on the number of tubers per cassava plant through the application of 200 kg ha^{-1} of the NPK compound 23:21:0:4S. The positive contribution of cassava number of tuber to the yield was showed in a study by [3] in which the number of tubers during maximum vegetative phase was found to be positively correlated with the tuber weight, as well as the number, length and diameter.

The differences in tuber numbers between the two genotypes were not affected by any interactions due to site and fertilizer level. This difference was due to the genetic superiority of *Sika* to yield more tubers per plant than *Bonima* genotype. The finding is in agreement with a study done in West Africa in which a comparison between 21 improved genotypes and four landraces showed that the lowest number of tuber was gotten by landraces genotype [29]. These findings are similar to the result obtained by [24] in Uganda who's showed that cassava yield was positively correlated with root number per plant. The scholar suggested that this trait contributed to the yield.

On cassava fresh tuber yield, a similar study in Malawi showed a significant inorganic fertilizer effect [22]. This is an indication that fertilizer application even at the lower rate was critical in increasing cassava fresh tuber yield. The cassava yields obtained from this study were low compared to other studies done in the region. This was mainly attributed to a prolonged drought the experiment experienced in the earlier growth period (Figure 2) and the fact that the harvest was done at only nine months after planting resulting in reduced opportunity for tuber filling. It is known that the critical period for water deficit effect on cassava is from 1 to 5 MAP corresponding to the stages of root initiation and tuberization; during which time water deficit for at least 2 months can reduce storage root yield between 32 to 60% [9] cite in [17]. In Nigeria, the application of 600 kg ha^{-1} of NPK (15-15-15) at 12 MAP produced 30.8 and 33.6 t ha^{-1} respectively from *TMS 92/0326* and *TMS 30572* genotypes [13]; Our finding fresh tuber yield lacked an optimum time to yield its potential. As suggested by [12] in Nigeria, a prolonged harvest beyond 12 months after planting ensure an optimum cassava root yields.

Under similar condition, the average yield of *Sika* genotype was twice that of *Bonima* genotype in agreement with a comparative cassava yielding study between local and improved genotypes in Cameroon where the improved variety achieved a fresh tuber yield two times higher than that of the local *Ntolo* genotype [27].

From Pearson Coefficient Correlation analysis it appeared that Loulouni site gave a better condition to yield contributing factor's to express better than at Finkolo. This finding is similar to study by [3] in which correlations between cassava growth parameters (plant height, stem diameter) and yield components (number of tuber by plant and fresh tuber yield) were recorded.

4. Conclusion and recommendation

The results of this study show that the application of the inorganic NPK (15-15-15) fertilizer significantly improves cassava growth and yield in the ultisols of Sikasso. However, the higher rates of fertilizers are required to obtain significant increases in cassava growth and yield, which is an indicator of low fertility level of these soils. An application rate lower than 200 kg ha^{-1} of NPK is not seem to provide enough nutrients for significant cassava growth. There also seems to be a strong interaction between fertilizer application and genotype with the improve *Sika* genotype being more responsive than the locally grown *Bonima* genotype. Therefore *Sika* genotype and the use of 300 kg ha^{-1} are recommended to get higher cassava yield in the study sites.

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