EFFECT OF DEPTH OF PLANTING, METHODS OF PLANTING AND ANIMAL RESIDUES APPLICATION ON THE GROWTH AND YIELD PERFORMANCE OF CASSAVA IN EJIBA, KOGI STATE, NIGERIA

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Abstract
This study was carried out in farmers' field, from March to December in 2014 and 2015 cropping seasons at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria to investigate the effect of depth of planting, methods of planting and animal residues application on the growth and yield performance of cassava (TMS 30572). The experiments consisted of 3 × 3 × 3 factorial in randomized complete block design with three replications. The planting depth imposed were: 7.5cm, 15cm and 22.5cm; planting methods evaluated were: (i) planting at 45^o (angle), (ii) planting at 90^o, and (iii) planting at 180^o and animal manure used were (i) poultry manure at 4 t/ha, (ii) cow dung at 4 t/ha and (iii) pig manure at 4 t/ha. These three factors were tested on cassava variety TMS 30572. Planting distance was 1m x 1cm giving a crop density of 10000 plant/ha. Average length of cutting was 25 cm. Growth and yield parameters taken were as follows: days to 50% germination, % number of plants remain on the field after 10 month of planting (%), number of primary stem, weight of 30 cm long stem, internode length (cm), average plant height, leaf area (m2), number of tuber per plant, number of marketable tuber per plant and yield per land area. Data were collected from ten randomly selected plants in each plot. From this experiment it can be concluded that cassava stem planted at depth of 15 to 22.5cm germinated better and had better survival rate on the field. Also, cassava planted at 45^o produced better growth and yield characters in this experiment. Cassava treated with poultry manure performs better in terms of growth and tuber yield in this experiment. It is therefore recommended that TMS 30572 should be planted at depth of 15 to 22.5cm, planting at 45° angle and poultry manure apply at the rate of 4t/ha be used as soil amendment for cassava production in the study area.

Introduction

Cassava (*Manihot esculenta*) is a member of the family *Euphorbiaceae.* It is an important crop of Africa, Asia, and Latin-America (Ravi *et al.* 1996). Cassava is produced mostly by smallholders on marginal and sub marginal lands in the humid and sub humid tropics (Philipp, 2005). It is efficient in carbohydrate production, adapted to a wide range of environments and tolerant to drought and acidic soils. An estimated 70 million people obtain more than 500 Kcal per day from Cassava (Kawano, 2003). Its ability to grow on poor soils and under difficult climatic conditions as well as the advantage of flexible root harvesting whenever there is a need, make it the 'crop of last resort' for farmer families and their domestic animals in the tropics (Hillocks *et al,* 2001). The importance of cassava as a food crop in Africa becomes obvious when its annual consumption per capita is compared to the rest of the world, while the World average of annual cassava consumption lies around 17 kg/capital in 2001, Africa's annual consumption is still above 80 kg/capital. Storage root has high starch content (89%) (Silvester, 1989). The leaves and tender shoots are important sources of vitamins, minerals, and proteins (Balagopalan, 2002); (Nweke *et al.*, 2002). The effect of method of planting on yield varies from country to country, and (Krochmal, 1969) attributed this to differences in the amount of rainfall. In some countries, completely burying the cuttings (horizontal planting) gave better yields than vertical

or slant planting [8]. In other countries, the opposite is the case. In Ghana and Nigeria, the method of planting does not seem to affect yield (Ekandem, 1962); (Opoku, 1962). Vertical method of planting cassava gave the best sprouting percentage of 88.8% than horizontal and inclined planting (Oguzor, 2007). (Mbah *et al*., 2008) reported higher tuber yield in vertical and inclined positions compared to horizontal method. (Keating *et al*., 1988) reported that planting method did not have significant effect on growth and yield of cassava.

Use of animal manures as a means of maintaining and increasing soil fertility has been advocated (Alasiri and Ogunkeye, 1999): (Smil, (2000). Animal manures, when efficiently and effectively used, ensure sustainable crop productivities by immobilizing nutrients that are susceptible to leaching. Nutrients contained in animal manures are released more slowly and are stored for a longer time in the soil, ensuring longer residual effects. Improved root development and higher crop yields (Tan, 2005): (Abou El-Magd et al., 2005). Animal manures are usually applied at relatively higher than inorganic fertilizer. When applied at high rate, they give residual effects on the growth and yield of succeeding crop (Makinde, and Ayoola, 2008). Improvements of environmental conditions as well as the need to reduce cost of fertilizing crops are reasons for advocating use of organic materials (Bayu *et al*., 2006). Animal manures improve soil fertility by activating soil microbial biomass (Ayuso *et al*., 1996). The objective of the study was to compare the effect of depth of planting, methods of planting and animal residues application on growth and yield performance of cassava (TMS 30572) in Ejiba, Kogi State, Nigeria.

Materials and Methods

This study was carried out in farmers' field from March to December in 2014 and 2015 cropping seasons at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria (Lat. 8˚18'N and Long. 5˚39'E). The site is 425 m above sea level, in the southern Guinea savanna agro-ecological zone of Nigeria, having hot dry seasons and also cool wet seasons. Twenty soil samples were taken at 0 – 15 cm depth using an augur for physico-chemical analysis. The samples were air dried, sieved to pass a 2 mm sieve, and analysed for texture (Tan, 2005), pH (Peech, 1965), total N (Tan, 2005), available P (Murphy and Riley, 1962), and exchangeable K (Tan, 2005).

Experimental procedures

The experiment was carried out over a period of 10 months from March to December in 2014 and 2015 in a 3 × 3 × 3 factorial in randomized complete block design with three replications. The planting depth imposed were: 7.5cm, 15cm and 22.5cm; planting methods evaluated were: (i) planting at 45^{o}, (ii) planting at 90^{o}, and (iii) planting at 180^{o} and animal manure used were (i) pig manure, (ii) cow dung and (iii) pig manure. These three factors were tested on cassava variety TMS 30572. Planting distance was 1m x 1cm giving a crop density of 10000 plant/ha. Average length of cutting was 25 cm. The planting material consisted of mature stem cuttings of about 25 cm in length, containing between ten and twelve nodes and planted along the top of the ridges. Each plot consisted of twenty four plants, with data being taken from ten plants within each plot.

Results and Discussion

Soil analysis of the site and chemical composition of animal manure used

The results of the soil analysis before planting and at ten month after planting are shown in Table 1a. The texture of the soils remained unchanged and it was classified as sandy clay loam. The observed soil acidification after ten month after planting could be due to leaching of ammonium in form of nitrate and crop removal of elements such as Ca and Mg (Chris, 2009). Total soil N was significantly reduced from an initial amount of 0.16% to 0.09%. CIAT (1983) reported that cassava depletes a large amount of N for root yield formation. Available P was generally increased from 2.48 to 3.16 mg kg^{-1}. The

organic matter at the start of the experiment was 3.54 g kg^{-1} which was reduced to 2.66g kg^{-1}at 10 month after planting (Table 1a). The reduction in organic carbon could be attributed to mineralization of organic matter to supply nutrients for plant uptake. Observations by Zingore et al. (2005) that organic matter content of tropical soils decline rapidly confirms the observed reduction in the organic carbon content of the soil. The chemical composition of animal manures used is shown in Table 1b. The chemical characteristics of materials differed significantly (p=0.05). Most of the materials were relatively high in the essential nutrients required for the growth and development of crop. However, their C/N ratio varied and ranges between 9.2 in poultry manure and 16.0 in cow dung manure. The rainy season spans from April to November and attains peaks in June while the dry season extends from December to March. The major soil order within the experimental site is ultisol (Ajiboye and Ogunwale, 2010). It is yellow to brownish in colour, deep and well drained. The rainfall data (mm), minimum and maximum temperatures (°C), and hours of sunshine in Ejiba during the experimental period are shown in Table 2.

Meteorological conditions of the study site

Table 2 presents some meteorological variables at the site of the experiment (mean of 2014 and 2015). Total mean annual rainfall was 1276 for 2014 and 2015 cropping seasons. The rainfall is mono-modal and occurred between April and October while dry season commenced in November and terminated in March the following Year. The rainfall amounts were highest in July in this area. Mean air temperatures was 31.5^0C for 2014 and 2015 cropping seasons. The total sunshine hour for the period of the experiment was 3,468 hours. Average sunshine hour per day was 9.5 hour for the period of the experiment. The results show that the environmental condition is suitable for the production of cassava.

Establishment and survival in cassava

Table 3 presents effect of depth of planting, method of planting and animal manure application on days to 50% germination in cassava and number of plant survived on the field at 10 months after planting. The results show that significant difference was observed in days to 50% germination and number of plant survive at 10 month after planting. However, no significant difference was observed due to different animal manure applied. Cassava stem planted deeper (15 to 22.5cm) established earlier and survived better at 10 month after planting, than cassava stem cutting planted at shallow depth (7.5 cm). Malumo (2001) reported that cuttings planted deeper have ease of establishment and survive better on the field. He attributed this to changes in soil moisture due to different depth. Soil moisture at shallow depth is more affected by ambient conditions than deeper layer (Keating and Evenson, 1979). Stem cuttings planted at 45^o and 180^o were not significantly different in days to 50% germination and number of plants on the field at 10 month after planting. However, they were significantly better than cuttings planted at 90^o in days to 50% germination and number of plants survives on the field after 10 month. The observed difference could be due to difference in hormonal action as a result of different orientation of the stem during planting. Both days to 50% germination and number of plant on the field after 10 month of planting were not significantly affected by the different animal manure applied.

Growth characters of cassava

Growth characters of cassava as influenced by depth of planting, method of planting and animal manure application are presented in Table 4. Plant height and weight of 30cm long stem per plant were significantly affected by depth of planting. 15 to 22.5 cm plants were better than plant with planting depth of 7.5 cm in both plant height and weight of 30 cm long stem. Number of primary stem, number of nodes per 30 cm long stem and internode length were statistically indifferent. Planting orientation significantly affect plant height, weight of 30 cm long stem and number of node per 30 cm long stem. Stem planted at 45 recorded tallest plants and produced heaviest weight of 30 cm long stem. This was

not statistically significant from stem planted at180^{o}. Vertical planted crop (90^{o}) had shortest plants but produced weight of 30 cm long stem per plant compared favourably with crops in 180 orientations. Cassava grow with poultry manure had tallest plant, heaviest stem of 30 cm long and longest internode length. This was statistically different from cassava treated with either cow dung and pig manure. (Jindasa *et al*., 1997) reported that poultry manure is generally considered the most valuable of livestock manure, builds up soil productivity better and also gives considerable increase in soil organic matter, available P and exchangeable cations. This could be responsible for better performance of plants treated with poultry manure in this experiment.

Yield and Yield Components of Cassava

Table 5 presents the effect of depth of planting, method of planting and animal manure application on number of tubers per plant, tuber dry matter content, weight of individual tuber, number of marketable tubers per plant, harvest index and weight of tubers per land area. Number of tubers per plant, average weight of individual plant and weight of tuber per hectare were highest in cassava with 15 cm depth of planting, followed by cassava planted at 7.5 cm depth while cassava stem planted at 22.5 cm had least of tuber, average weight of individual tuber and weight of tuber per hectare. Cassava stem planted at 45^{o} produced more number of tubers than those planted at 90^{o} and 180^{o}. Mbah et al. (2008) reported higher tuber yield in inclined positions compared to horizontal method. Poultry manure treated cassava were better than either cow dung or pig manure treated cassava in number of tubers per plant, weight of individual tuber and weight of tubers per hectare. Poultry manure had lower C/N ratio and higher N content than others, which indicated that N mineralization could be easier than cow dung and pig manure. This could be responsible for better yield in cassava amended with poultry manure. No significant difference in the nutrient compositions (ash%, moisture%, protein%, crude fibre % and total CHO %) of cassava tubers caused by different depth of planting, different methods of planting and different animal manure applied in this experiment.

Conclusion

From this experiment it can be concluded that cassava stem planted at depth of 15 to 22.5cm established better and had better survival rate on the field. Cassava planted at 45^{0} and applied with 5 tons/ha of poultry manure as soil amendment for cassava production also performed optimally. Cassava treated with poultry manure performed better in terms of growth and tuber yield in this experiment. It is therefore recommended that TMS 30572 stem should be planted at depth of 15 cm, inclined at 45^{0} and poultry manure apply at the rate of 5t/ha be used as soil amendment in cassava production in the study area. Further research is advocated using different varieties of cassava.

Table 1a: Pre-planting soil analysis

Soil characteristic	***Before the experiment***	***After the experiment***
pH ($CaCl_2$)	5.68	5.42
Nitrogen (%)	0.16	0.09
Phosphorus (mg/kg)	2.48	3.16
Potassium (meq/100g	0.18	0.16
Calcium (cmol/kg)	2.61	2.51
Magnesium (cmol/kg)	2.87	2.84
Organic matter (%)	3.54	2.26
Bulk density (g/cm^3)	1.37	1.39
Total porosity (%)	43.4	43.8
Sand (%)	60.2	61.0
Clay (%)	24.0	24.6
Silt (%)	15.8	14.4
Textural class	Sand clay loam	Sand clay loam

Table 1b: Chemical composition of animal manures used

Properties	*Poultry manure*	*Cow dung*	*Pig manure*
Organic carbon (%)	38.6	43.1	40.4
Total N (%)	4.2	2.7	2.8
C/N Ratio	9.2	16.0	14.4
Phosphorus (%)	1.61	1.84	1.69
Potassium (%)	3.2	3.4	4.8

Table 2: Weather characters of the experimental site (average of 2014 and 2015 seasons).

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
RF(mm)	0	0	0	36.4	168.8	213.4	259.4	217.1	226.4	138.4	12.6	0
Temp.(^{0}C)	30.4	30.6	31.3	31.2	31.0	31.1	**30.2**	30.1	30.6	31.1	31.3	31.0
SS(hr)	281	293	292	292	289	280	284	291	266	271	276	289
No of rainy days	0	0	0	02	08	17	16	07	11	05	01	0

Table 3: Rate of survival in cassava as influenced by depth of planting, method of planting and application of animal manure

Treatment	*Days to 50% establishment*	*Plant on the field at 10 month after planting (%)*
Depth of planting (A)		
7.5cm	15.8	67.14
15cm	12.6	87.66
22.5cm	12.4	95.14
LSD	2.44	10.99
Method of planting (B)		
45^o	12.8	92.6
90^o	15.4	74.3
180^o	12.2	93.1
LSD	1.36	2.64
Animal manure (C)		
Poultry manure	12.6	86.4
Cow dung	12.1	88.3
Pig manure	12.8	88.1
LSD	NS	NS
Interaction		
A*B	NS	NS
A*C	NS	NS
B*C	NS	NS
A*B*C	NS	NS

NS, not significant at p=0.05

Table 4: Growth characters of cassava as influenced by depth of planting, method of planting and application of animal manure

Treatment	*Plant Height (cm)*	*Number of primary stem*	*Weight of 30 cm long stem per plant (g)*	*Number of node per 30 cm long stem*	*Internode length (cm)*
Depth of planting (A)					
7.5cm	183.6	2.66	43.61	12.43	2.86
15cm	218.4	3.01	56.71	12.73	3.01
22.5cm	204.1	2.74	54.87	11.64	2.92
LSD	21.9	NS	06.11	NS	NS
Method of planting (B)					
45^o	211.4	2.71	62.28	10.12	2.87
90^o	166.8	3.06	51.56	13.04	2.62
180^o	198.4	2.94	50.87	10.41	2.69
LSD	21.4	NS	04.6	1.21	NS
Animal manure (C)					
Poultry manure	222.2	3.13	69.81	09.32	3.32
Cow dung	198.6	2.94	56.46	12.71	2.47
Pig manure	194.9	2.86	55.93	12.29	2.71
LSD	6.3	NS	3.44	1.06	0.44
Interaction					
A*B	NS	NS	NS	NS	NS
A*C	NS	NS	NS	NS	NS
B*C	NS	NS	NS	NS	NS
A*B*C	NS	NS	NS	NS	NS

NS, not significant at p=0.05

Table 5: Yield characters of cassava as influenced by depth of planting, method of planting and application of animal manure

Treatment	*No of tuber per plant*	*Tuber dry matter content (g)*	*Average weight of individual tuber (g)*	*No of marketable tuber per plant*	*Harvest index*	*Weight of tuber per hectare (t/ha)*
Depth of planting (A)						
7.5cm	7.67	41.16	363	6.28	0.40	27.84
15cm	8.33	42.27	496	7.43	0.44	41.32
22.5cm	5.41	41.44	284	5.41	0.36	15.36
LSD	0.69	NS	79	0.66	NS	13.76
Method of planting (B)						
45^o	8.69	42.41	374	8.26	0.41	32.50
90^o	5.88	41.60	251	4.85	0.43	14.76
180^o	9.14	42.63	301	5.62	0.45	27.51
LSD	2.28	NS	24.1	2.31	NS	6.88
Animal manure (C)						
Poultry manure	8.87	42.32	389	6.8	0.51	30.61
Cow dung	8.16	41.99	301	6.2	0.48	24.56
Pig manure	7.49	41.52	296	6.6	0.50	22.17
LSD	0.32	NS	21.04	NS	NS	3.41
Interaction						
A*B	NS	NS	NS	NS	NS	NS
A*C	NS	NS	NS	NS	NS	NS
B*C	NS	NS	NS	NS	NS	NS
A*B*C	NS	NS	NS	NS	NS	NS

NS, not significant at p=0.05

Table 6: Nutrient composition of cassava tuber as influenced by depth of planting, method of planting and application of animal manure

treatment	*Ash (%)*	*Moisture (%)*	*Protein (%)*	*Crude fibre (%)*	*Total CHO (%)*
Depth of planting (A)					
7.5cm	2.31	58.84	32.7	11.3	34.6
15cm	2.34	57.73	33.1	12.4	32.9
22.5cm	2.41	58.56	33.4	11.8	34.3
LSD	NS	NS	NS	NS	NS
Method of planting (B)					
45^o	2.26	57.59	32.2	12.5	33.8
90^o	2.31	58.40	33.4	12.9	33.9
180^o	2.33	57.37	33.6	12.0	32.1
LSD	NS	NS	NS	NS	NS
Animal manure (C)					
Poultry manure	2.34	57.63	33.4	11.9	34.4
Cow dung	2.21	58.01	32.8	12.1	34.0
Pig manure	2.34	58.48	32.5	12.4	33.8
LSD	NS	NS	NS	NS	NS
Interaction					
A*B	NS	NS	NS	NS	NS
A*C	NS	NS	NS	NS	NS
B*C	NS	NS	NS	NS	NS
A*B*C	NS	NS	NS	NS	NS

NS, not significant at p=0.05

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