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Response of cassava (*Manihot esculenta* CRANTZ) Varieties to dry season planting in port harcourt, Rivers state, Nigeria

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Abstract

The trial on responses of cassava varieties to dry season cropping in Port Harcourt, Rivers State was conducted at the Teaching and Research farm of the University of Port Harcourt, Rivers State of Nigeria. The aim of the research was to determine the best cassava variety that can withstand drought and perform better in the dry season within the area. A complete randomized block design with three replicates on each planting date was adopted. Two cassava varieties- TMS 30572 (Brown skin) and TMS 98/0505 (Off- white skin) were used for the study due to its availability within the region. The dry season dates chosen for planting were December 21, 2010 (Dry-season); January 21, 2011 (Dry-season+ Harmattan); and February 21, 2011(Dry-season + 4 conventional rains). The result of the trial showed that the cassava variety- TMS 98/0505 is more tolerant to drought and less tolerant to the cloudiness of the rainy period in the Port Harcourt area than TMS 30572.On yield, TMS 98/0505 produced 7.0tons/ha in December, 5.52 tons/ha in January and 3.89 tons/ha in February planting, While TMS 30572 produced 5.57tons/ha in December, 5.05 tons/ha in January and 5.77 tons/ha in February. Therefore TMS 98/0505 is recommended for planting in Port Harcourt, Rivers State during the dry season period. This will bring about all year round planting of this very important crop which will lead to increased or even doubled production of cassava for domestic, industrial and export purposes.

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Introduction

Cassava (*Manihot esculenta* Crantz) is a major food crop in the humid and sub-humid parts of Africa and a major source of energy for millions of people in these regions. It is the most important root crop in Nigeria in terms of food security, employment creation, and income generation for crop producing households because of its ability to grow under a wide range of conditions, some of which are unsuitable for other crops (Ugwu and Ukpabi, 2002; Nweke, 2003).

It is one of the most important root crops in the tropics, feeding over 50 million Nigerians with more than 70% of their daily energy requirements. Cassava is a food security crop providing 2.2 times as many calories per hectare as maize, 2.7 times as much as yam and 1.5 times as much as sweet potatoes (FAO, 2013). The crop is one of the most dominant and main crop components in crop mixtures in south-eastern Nigeria and it is gradually gaining importance as an industrial crop. Nigeria's annual production of cassava is estimated at 49 million tonnes. About 90 percent of it is used as food. Yet Nigeria, the world's largest producer of cassava (FAOSTAT, 2010) has not attained self-sufficiency in cassava production as 100 million tonnes of the commodity is required annually to contribute in guaranteeing food security for the nation where about 65 percent are food-insecure, i.e., insufficient access to the amount and variety of food for a healthy and productive life.

Cassava is one of the most important staple foods in the human diet in the tropics, and ranked as the sixth most important source of calories in the human diet worldwide. FAOSTAT, (2010) reported that total production of cassava in Africa had increased from35 to 80 million tons between 1965 and 1995, with Nigeria leading the rest of Africa. In many parts of Africa, cassava leaves and tender shoots are consumed; because the leaves contain about 7%of protein (fresh weight) and a high level of lysine. The daily per capital consumption of cassava in Nigeria contributed about one mega joule (MJ) to the diet. Estimated household consumption is about 30 million metric tonnes with a marketable surplus for industrial demand of about 10% of total production (Nwachukwu, 2005). It is a source of income for most rural dwellers where it is processed into gari, starch, and animal feed or cassava chips. The products are used for the production of industrial alcohol, cosmetics, and pharmaceuticals and in the textile industry (IITA, 1990). This makes it an important commodity to be transported to neighboring countries including Mali, Niger and Burkina Faso. Cassava cropping is also used to regenerate degraded soils (Adjei, 2012) as in some parts of East Africa and in Benin. In West Africa for instance, cassava has become a very popular crop and is fast replacing yam and other traditional staples gaining grounds increasingly as an insurance crop as against hunger (Balogoplan, 2004). The main food product which is the tuberous roots can be harvested from the soil up to three years after maturity (Lebot, 2009). This provides an important form of insurance against social disruption, prolonged droughts, or other periods of stress and unrest. The nutritional value of the storage root is mainly caloric even though it contains a lot of water, fibre, ash and protein (Marcelis and Heuvelink, 2002). The leaves contain about 30% proteins by dry weight and are eaten in some parts of Africa as vegetable (Burns *et al*; 2010). Cassava is one of the most adaptable plants. It is very hardy and tolerant to a wide range of soils. It grows well in tropical humid conditions but can also withstand droughts. It does well in poor soil. It requires little care and protects itself against predators by means of poisonous latex, which is particularly evident in the leaves (Pujol*et al.,* 2005). It is an ideal food crop for tropical growing.

The major uses of cassava in Nigeria include flour. Other products include garri, cream-white granular flour with a slightly fermented flavor and slightly sour taste (Philip *et al.*, 2005).

The adaptation range of cassava cultivars is wide. Cassava can be grown in areas where the annual rainfall is as low as 500 mm, and can survive in areas with dry seasons as long as 8 months. Because of such hardiness, farmers in semiarid areas rely on cassava as a 'famine crop'. Cassava survives under such extreme conditions because the plant conserves water through several mechanisms. At the beginning of a dry season, the production of new leaves is reduced and excessive leaves are shed. However, cassava has the ability to produce new leaves while more leaves are shed.

In view of the ever increasing world human population, particularly in developing countries, increasing demands for food and feed in the coming few decades must be met by enhancing agricultural outputs as well as conserving dwindling natural resources, particularly arable lands and water. In developed and industrial countries of the temperate zone, the gap between the potential productivity of crops and actual yields had been largely closed aided by advanced public and private research that has resulted in improved technologies. On the other hand, in developing countries in general, and in the tropics in particular, agricultural productivity is still far below the potential. This situation will be further aggravated in light of the recognized global climate changes that might result in adverse effects on agricultural systems and food security in developing countries (Jarvis, *et al.,* 2012).

Local farmers in Nigeria plant cassava from the beginning to the end of the rainy- season. Duration of the rainy – season varies between geographical zones in Nigeria. In the high rain forest zone which includes the Niger Delta, rains begin to fall infrequently from the middle of February and increases and decline to the middle of November (9 months) and the dry season last mainly from middle of November to middle of February (3 months). Cassava is therefore not planted within this period of the dry season. But in the Niger Delta where the dry-season lasts for only 3 months, it is not known whether cassava varieties planted during these 3 months of dry season could give good yield performance. Therefore, the main purpose of this investigation is to determine the best cassava variety that can withstand drought and perform better in the dry season within the study area.

Materials and methods

Experimental site

The study was carried out at the University of Port Harcourt Institute of Agricultural Research and Development Farm. The University is on latitude 4°31' to 5°N and longitude 6°41' to 7°E, with an average temperature of 27°C, relative humidity of 78% and average rainfall that ranges from 2500 – 4000mm (Nwankwo and Ehirim, 2010).

The dry season is short, lasting from December through February; the wet (rainy) season begins from March and continues through November. Maximum rainfall occurs during the months of June to October with mean annual rainfall of 2233mm. The mean monthly temperature ranges between 28°C and 33°C, while the monthly minimum is between 20°C and 23°C. The highest temperature figures recorded are in the months of December to March. The soil is of sandy clay loam characterized as Ultisol. Initial soil samples were collected at random for analysis on each planting date at 0 – 15cm and 15cm – 30cm depth one week before land preparation. A second soil sample was taken on 23rd May, 2011. The essence was to determine the field capacity of the experimental field 24 hrs after a heavy rainfall.

Cultural practices

The land area measuring 12m x 10m in each of the planting periods were cleared and prepared two (2) weeks before actual planting was done in all the cropping periods. A planting space of 1m x 1m was adopted and mounds were prepared for the planting with 50cm as part way. The mounds measured 30cm wide and 15cm high. The size of each plot was 5m x 4m. A complete randomized block design with three replicates on each planting date was adopted. Two cassava varieties- TMS 30572 (Brown skin) and TMS 98/0505(Off- white skin) were used for the study due to its availability within the region. The dry season dates chosen for planting were December 21, 2010 (Dry-season); January 21, 2011 (Dry-season+ Harmattan); and February 21, 2011(Dry-season + 4 conventional rains). The planting materials (Cassava stems) were obtained from Rivers state Agricultural

Development Project (ADP), Rumuodomaya, Port Harcourt. The cassava stems were cut into 20cm length and planted at 25° on the mounds at each planting periods. After planting, poultry manure was spread on each mound at the rate of 416.7g per mound or 4.2t/ha. The aim was to protect the mounds from excessive heat of the sun. The poultry droppings contained organic matter and nutrients especially nitrogen.

Data collection/Analysis

Field observations were made on germination counts, growth and yield parameters from all the three cropping dates, such as plant height (cm), number of stems, number of nodes, number of leaves per plant, while on yield parameters, number of root tubers and weight of tubers were taken. Data was statistically analyzed using Genstat Discovery Edition 4. The analysis of variance (ANOVA) was performed to find out the significance of variation among the treatments while the significance difference between mean treatments were separated using the least significant difference at 5% level of probability.

Results

The Soil moisture content (%) was lowest in February owing to Harmattan, as shown in Table 1. The result showed that the available soil moisture content determined the percentage number of cutting that survived. TMS 30572 cuttings survived more than TMS 98/0505.

Table 1. Soil moisture data (%).

Date of planting	0 – 15cm	15 – 30cm	Remarks
First date of planting (December 21)	9.69	12.06	Dry season
Second date of planting (January 21)	6.80	10.00	Dry season + Harmattan
Third date of planting (February 21)	12.15	14.30	Dry season + 4 conventional rains
moisture content at field capacity (May 23rd)	15.20	16.30	

Soil moisture content was lowest during Harmattan (January).

Growth parameters

Table 2 to 4 shows the values for growth parameters at 120 days after planting for all the cropping periods of cassava varieties studied.

On number of leaves per plot at 120 DAP, the average, TMS 30572 had more leaves than TMS 98/0505 in all the three dates of planting. However in both varieties, the later dates of planting had no significant effect on the number of leaves than in the first date of planting (December 21).

The Plant height of TMS 30572 at 120 DAP was taller in all the dates of planting with average difference of 0.24m ($P < 0.01$).

In both varieties, the later the planting date, the tall the cassava stems ($P < 0.01$).Although the difference in height between the varieties reduced with delay in planting date, the relationship between the rate of reduction and time of planting was not significant.

Table 2. Effect of dry season cropping on growth parameters in December 21,2014at 120 DAP.

Cassava Varieties	Germination (%)	Plant height (m)	Number of stems	Number of nodes	Number of leaves
TMS 30572	71.67	1.45	1.56	71.33	52.22
TMS 98/0505	66.67	1.06	1.56	58.56	45.33
LSD (0.05)		0.12	0.64	6.60	4.41

At plant harvest, the average number of stem count per plant arising from each variety planted was higher in TMS 30572 than in TMS 98/0505 ($P < 0.05$). First time of planting (Dec. 21) had significantly fewer numbers of stems (1.56)than the second (3.00) and third (2.56) dates of planting. At final harvest TMS 30572 had 2.1 mature stems/mound while TMS 98/0505 had 1.4 stems/mound ($P < 0.05$). At final harvest also, the second and third dates of planting had 2.7 numbers of stems than the first date of planting.

On number of nodes on each plant at 120 DAP; the TMS 30572 had more nodes per plant than TMS 98/0505 in all the periods of planting. Date of planting had no effect on the number of nodes. Also, TMS 30572 had longer inter-node length than TMS 98/0505 (P <0.05). Inter-node length increased as date of planting was delayed (P <0.01), interaction between variety and date of planting was not significant at both cases.

Table 3. Effect of dry season cropping on growth parameters in January 21, 2015 at 120 DAP.

Cassava varieties	Germination(%)	Plant height (m)	Number of stems	Number of nodes	Number of leaves
TMS 30572	100	1.74	3.00	82.56	56.22
TMS 98/0505	90	1.43	1.44	61.00	50.89
LSD (0.05)		0.12	0.64	6.60	4.41

Table 4. Effect of dry season cropping on growth parameters in February 21, 2015 at 120 DAP.

Cassava varieties	Germination(%)	Plant height (m)	Number of stems	Number of nodes	Number of leaves
TMS 30572	100	1.74	2.56	84.22	57.00
TMS 98/0505	100	1.70	1.78	64.78	50.89
LSD (0.05)		0.12	0.64	6.60	4.41

The number of leaves also followed the same trend where TMS 30572 produced higher number of leaves than TMS 98/0505 in all the different dates of planting.

Yield parameters

On tuber Yield in Tables 5, 6, 7, there was no significant difference in overall root tuber yield between TMS 30572 and TMS 98/0505 after 6-8 months of growth and development. Average tuber yield tended to decline with delay in time of planting from December to February steadily in TMS 98/0505 than in TMS 30572.

Table 5. Effect of dry season cropping on yield components in December 21, 2014 planting.

Cassava varieties	No. of root tubers /plot	Weight of tubers (tons/plot)	Average length of tubers (cm)
TMS 30572	51.67	5.27	70
TMS 08/0505	32.67	7.00	58
LSD (0.05)	16.35	1.26	6.50

TMS 30572 had a larger number of root tubers per plot than TMS 98/0505 with average tuber weight of 158.7g /tuber and 281.1g/tuber respectively. TMS 98/0505 tubers were also longer by 15.4 %.

Discussion

This work showed that TMS 30572 is less responsive to environmental stress than TMS 98/0505 since it maintained fairly constant yields throughout the experimental period. Although the yields of TMS 98/0505 was slightly higher than that of TMS 30572, which had longer and more number of tubers, the experiment showed that cassava yield is independent of tuber length or number. This is in accordance with (IITA, 2012) report on the characteristics of some of their varieties.

Table 6. Effect of dry season cropping on yield components in January 21, 2015 planting.

Cassava varieties	No. of root tubers /plot	Weight of tubers (tons/plot)	Average length of tubers
TMS 30572	62.00	5.95	65
TMS 98/0505	56.67	5.52	55
LSD (0.05)	16.35	1.26	6.41

Cassava tubers can be conical, cylindrical or irregular in shape. TMS 30572 was taller and had more leaves than TMS 98/0505 (Table 2), which had slightly more tuber weight. This work showed that there is no direct relationship between height, number of branches or leaves and tuber yield. According to IITA report, (NAERLS, Bulletin No. 224), TME 419 grows up to 3-4m with no branches has a yield potential of 35.2t/ha, whereas TMS 97/2205 which grows up to 2m tall and branch profusely has a yield potential of 31.8t/ha and so there is no direct relationship between the afore mentioned components rather cassava has inherently high leaf photosynthetic capacity at high temperatures coupled with high solar irradiances and responds positively to elevated Carbondioxideconcentrations (El-Sharkawy*et al.*,1992).

Table 7. Effect of dry season cropping on yield components in February 21, 2015 planting.

Cassava varieties	Number of root tubers/plot	Weight of tubers (tons/plot)	Average length of tubers
TMS 30572	89.00	6.77	60
TMS 98/0505	27.33	3.89	50
LSD (0.05)	16.35	1.26	4.54

Cassava is equipped with a tight stomatal control mechanism over gas exchanges which are more sensitive to changes in air humidity and soil water status than other crops (El-Sharkawy, 2004). Cassava makes maximal use of solar radiation by changing leaf size, angle and/or orientation (Fermount, 2009). Vertical arrangements enhance interception of light of low sun angles during early morning or late afternoon and reduce interception at solar noon when radiation levels are highest. Change in leaf orientation can also be done to avoid high light.

Table 8. IITA reports on characteristics of some cassava varieties.

Variety	Average potential yield	Average number of roots	Average length of roots
TMS 92/0326	25t	9.7	75cm
TMS 96/1414	30t	9.0	60cm
TMS 96/0023	20t	8.0	30cm
TMS 92/0057	25t	8.5	60cm

(Source: IITA, 2012).

Cassava plant is resilient in nature with plasticity in its growth habits growing several branches on main stems associated with reproductive organs(flowers, fruits and seeds) in most cultivars, thus providing sinks in addition to its starchy storage roots for extra-photo-assimilates. Short stemmed cassava varieties showed root yield that approached the tall cassava with tendency to early storage root filling (Pellet and El-Sharkawy,1993).

The leaf photosynthetic capacity in cassava remains remarkably high. It is considered a C_3-C_4 intermediate species based on several physiological, anatomical and biochemical leaf traits (El-Sharkawy, 2006). Cassava leaves possess elevated phosphoenolpyrurate carboxylase (PEPC) activity that reaches 10%-25% of those in C_4 tropical crops such as maize, and sorghum and much greater than activities observed in typical C_3 plants such as common bean (El-Sharkawy,2006). This is important in cassava ability to fix carbon as PEPC has higher activity and more affinity to CO_2 than the C_3Rubisco (Ribulose -1, 5 bisphosphate Carboxylase Oxygenase), particularly at higher temperatures and soil water stress.

The work also showed a direct relationship between cassava plant height and number of nodes. TMS 30572 had taller stems and higher number of nodes (Table 1).

Unlike most other crops, cassava does not have a critical period during which adequate soil moisture is essential for flowering and seed production. It has several defense mechanisms that help it conserve water, although the cassava fine root system is sparse, compared to other crops, it can penetrate below 2 meters soil, thus enabling the crop to exploit deep water if available (El-Sharkauy, 2004). The crop is adapted to semi-arid conditions, it needs adequate soil moisture mainly during planting, once sprouted it can withstand some months of drought, once established, cassava can grow in very dry areas. Among the world's major staple food crops, cassava is well-known for its ability to produce reasonable yields on poor soils in areas with low or erratic rainfall, and without agrochemicals and other external inputs. Those hardy traits have made cassava highly suitable for low-input, small-scale agriculture, while its inherent potentials have placed it among the crops most suitable for resource-poor farming in tropics and neo-tropics under 21st century climate change scenarios(Romanoff and Lyman,1992).

On yield, there was no significant difference in overall root tuber yield between TMS 30572 and TMS 98/0505 after 6-8 months of growth and development in all the periods of planting. Average tuber yield tended to decline with delay in time of planting from December to February steadily in TMS 98/0505 than in TMS 30572. And this showed that planting cassava during the dry season did not affect cassava yield adversely in the Niger Delta.

Conclusion

The result showed that TMS 30572 is more tolerant to drought and less tolerant to the conditions of the rainy period because of its inherent potentials and traits. Therefore it is better suited for growth and yield in the more Northerly latitudes of Nigeria with longer periods of dry season and longer duration of bright sunshine and in the study area for sustainable cultivation of the crop.

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