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# Assessment of farmers' field for root rot disease on improved cassava varieties released in Nigeria

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## Abstract

More cassava is grown in Nigeria than anywhere else, but production is still limited by several factors including root rot disease which is common in cassava growing areas. A survey was carried out to assess farmers' fields for yield and root rot disease on cassava varieties in seven States of Nigeria. Field assessment was based on 5 m by 5 m quadrats in two locations within a plot by counting the number of plant stands, total number of fresh roots, number of rotted roots, and weight of fresh roots within the quadrat. Across States and within varieties there were significant differences ($P \leq 0.05$) in number of plants, total root number, fresh root yield (t/ha) and rot (%). This could be attributed to differential management practices, soil type and fertility, age of crop, and environmental conditions. The highest fresh root yield was observed on Abutu (52.2 t/ha); the lowest yield was on Bendel (5.4 t/ha). Both are local varieties. Improved varieties had a comparative yield advantage of 20 t/ha local varieties despite the fact that more rots (11.1%) were observed on improved varieties than on local varieties (2%). The damage experienced on improved varieties was largely due to the age of the crop and susceptibility to waterlogged fields. These underscore the need for farmers growing improved varieties not to leave their cassava on the field for more than 15 months, especially if such fields are prone to waterlogging. Botryodiplodia theobromae, A. niger, A. flavus, F.usarium solani, F. oxysporum, and Armileria melea were associated fungi recovered from the rotted samples across locations.

**Keywords:** Cassava, yield, root rot, fungal pathogens, farmers' field assessment.

## Introduction

Cassava (*Manihot esculenta* Crantz) is a major food crop for an estimated 260 million people in Africa (El-Sharkawy, 1993). Nigerian cassava production is by far the largest in the world; one-third more than the production in Brazil and almost double the production of Indonesia and Thailand. Cassava production in other African countries, such as the Democratic Republic of the Congo, Ghana, Madagascar, Mozambique, Tanzania, and Uganda, appears small in comparison with Nigeria's substantial output (Philips et al. 2004). Much of the cassava is produced in the forest, derived, and southern Guinea savanna agroecozones of Nigeria that largely fall within the areas with good soil and adequate rainfall. Although cassava can produce a crop with minimal inputs, optimal yields are recorded from fields with average soil fertility levels for food crop production and regular availability of moisture.

Cassava ranks highly as a major staple food crop, particularly for the low income earners and resource-poor farmers in the developing economies of sub-Saharan Africa (Hahn *et al*. 1989). However, in recent times, the crop is progressively gaining a strategic position in global trade as a result of the efforts by various research and development stakeholders in developing value-added cassava-based products for human consumption and industrial uses (Onyeka et al. 2005). Various food applications take advantage,of properties of cassava starch, the odorless, clear paste and high freeze-thaw stability, (Plucknett et al. 2003). The starchy roots can be processed into *gari*, *fufu, lafu, Kpokpogari*, or *bobozi*; they also used for making tapioca. Industries take advantage of the clear appearance of cassava starch and the sticky texture of its cooked paste in the manufacture of adhesives and glue (CSTRU, 2007). Processed cassava starch can compete with other starches for sizing paper and textiles, producing pharmaceutical dustings and disintegrating pills, biodegradable products, ethanol and acetone, explosives, and corrugated boxes (Plucknett et al. 2003).

Ezedinma et al. (2007) in a study to assess the trends in cassava production since the 1990s indicated that the increase in production in Nigeria is principally as a result of area expansion rather than increased yield /ha. The causes for low yields/ha are diverse but diseases and numerous pests are known to partially contribute. Diseases affect plant establishment and vigor, inhibit photosynthetic efficacy, and in some cases cause pre-harvest or post-harvest deterioration (Lozano et al. 1981; IITA 1990). Diseases can lead to total crop failure with losses in tuber yield as high as 90% under favorable conditions (Wydra and Msikita, 1998). Among the diseases that attack cassava, the incidence of root rots has been reported to be higher in the forest areas than in other ecologies (Chalwe et al. 1999; Onyeka 2002). The stagnation in yield may be connected with the activities of the soil's hidden root rot fungi; especially when the improved varieties cultivated were not deliberately developed for root rot resistance. Root-rotting pathogens affect mostly the underground portion of the plant (and are hence out of sight). Because the plant has an extensive root system (and thus can remain standing despite a significant portion of its roots being rotted), the nature and extent of the root rot problems are poorly understood and quantified in Africa. Compared with other major diseases of cassava, root rots caused by several fungi are the most poorly understood and among the least studied (Bandyopadhyay et al. 2006). Root rot, apart from reducing yield, can also reduce the quality of roots harvested. Thus this current study tends to assess cassava yield and the incidence of root rots on improved and local cassava varieties on farmers' fields in seven States of Nigeria.

## Materials and Methods

**Survey sites and sampling.** The study was carried out in Oyo, Osun, Ondo, Ekiti, Kogi, Benue, and Nasarawa States (Table 1). Oyo State is located within the derived savanna zone of the country. With a bimodal rainfall distribution averaging between 1300 and 1500 mm annually, and maximum temperatures varying from 25 to 35°C. Osun, Ondo, and Ekiti States are within the humid forest, characterized by two growing seasons, starting from April to November with an annual rainfall of 1500 to 2000 mm, average annual temperature of 24.5 to 27.5°C. Kogi, Benue, and Nasarawa States lie within the southern Guinea savanna zone with an annual bimodal rainfall averaging between from 1000 mm to 1300 mm , and temperatures ranging from 26 to 38°C.

The study was initiated in November 2010 and continued for 2 months. Sixty-two farmers selected from 80 villages were involved. The villages were selected based on propagative materials distributed to the farmers in the previous year by IITA, Ibadan through the project of USAID-*Unleashing the Power of Cassava in Africa* . Fields that were planted during a similar period were selected to minimize variation caused by different planting dates. Generally, planting took place between July and August 2009. In each farmer's field, a quadrat measuring 5 m × 5 m area was demarcated in two spots where observations were recorded. Observations were made on number of plant stands in a quadrat, total number of roots, number of rotted roots, and weight of fresh roots. Rotted samples were randomly selected for the isolation of the associated fungi.

Data collected were subjected to analysis of variance using general linear model procedure. Means were separated by Duncan Multiple Range Tests (DMRT).

**Isolation and identification of associated fungi in the laboratory.** Roots showing rot symptoms were collected from each site where the diseases were observed during the survey for the detection of the associated pathogen in the laboratory. Isolation of rot pathogens was carried out on acidified potato dextrose agar (PDA). Small tissue pieces of diseased samples were surface sterilized for 3 min in 10% sodium hypochlorite solution, rinsed in 5 changes of sterile distilled water and dried on sterilized paper towels before inoculation on acidified PDA. The inoculated plates were incubated at 27 °C for 5–7 days during which pure cultures of microbial growth were established for identification. Confirmation of associated causal pathogens of rot was carried out, based on the morphological and cultural characteristics on PDA, and microscopic observation following the fungi identification key of Barnett and Hunter (1998).

## Results and Discussion

A total of 29 cassava varieties were examined during the survey, 13 improved and 16 local varieties. The number of plants and total number of roots differed significantly ($P \leq 0.05$) between States and varieties (Table 2), which indicates that farmers did not use the

Table 1. Farmers' location and coordinates of each location collected during the survey.

| State | LGA | Village | Longitude | Latitude |
|---|---|---|---|---|
| Oyo | Akinyele | IITA Idi-Ose | 7 49.895 | 3 90.706 |
| Oyo | Ido | Aafa Dauda | 7 29.615 | 003 44.129 |
| Oyo | Ido | Idi Amu | 7 31.343 | 003 42.204 |
| Oyo | Ido | Ilaju | 7 32.917 | 003 35.975 |
| Oyo | Ido | Elere Akilo | 7 31.271 | 003 37.709 |
| Oyo | Ido | Elere Akilo | 7 31.478 | 003 38.350 |
| Oyo | Ibarapa East | Idi Ata | 7 31.563 | 003 32.954 |
| Oyo | Ibarapa East | Idi Ata | 7 31.896 | 003 33. 078 |
| Oyo | Ibarapa East | Idi Ata | 7 32.233 | 003 32.761 |
| Oyo | Ibarapa East | Olokete | 7 32.103 | 003 28.107 |
| Oyo | Ibarapa East | Olokete | 7 32.086 | 003 28.030 |
| Oyo | Saki East | Igbo Osanyin, Ago Amodu | 8 36.095 | 003 36.600 |
| Oyo | Saki East | Igbo Osanyin, Ago Amodu | 8 35.756 | 003 36.397 |
| Oyo | Saki West | Aba Ogbomosho | 8 44.940 | 003 28.523 |
| Oyo | Saki West | Aba Ogbomosho | 8 44.616 | 003 28.997 |
| Oyo | Saki West | Aba Ogbomosho | 8 43.540 | 003 27.088 |
| Oyo | Kajola | Elewure | 8 02.447 | 003 25.475 |
| Oyo | Kajola | Elewure | 8 02.320 | 003 25.520 |
| Oyo | Kajola | Elewure | 8 02.136 | 003 26.854 |
| Oyo | Kajola | Elewure | 8 02.416 | 003 25.505 |
| Oyo | Oyo West | Fasola | 7 54.625 | 003 45.744 |
| Oyo | Oyo West | Fasola | 7 54. 665 | 003 45.817 |
| Oyo | Atiba | Busari | 7 57.776 | 004 02.650 |
| Oyo | Atiba | Sakuta | 08 02.926 | 003 99.426 |
| Oyo | Atiba | Sakuta | 08 03. 038 | 003 59.314 |
| Osun | Aiyedire | Ile Ogbo | 07 35.972 | 004 17.143 |
| Osun | Aiyedire | Ile Ogbo | 07 35.357 | 004 16.704 |
| Osun | Aiyedire | Ile Ogbo | 07 35.679 | 004 16.844 |
| Osun | Aiyedire | Ile Ogbo | 07 35.655 | 004 16.825 |
| Osun | Aiyedire | Ile Ogbo | 07 35.791 | 004 17.130 |
| Osun | Odo-Otin | Oponda | 08 03.035 | 004 40.753 |
| Osun | Odo-Otin | Oke-Otin | 07 59.480 | 004 41.480 |
| Osun | Odo-Otin | Oke-Otin | 07 59.035 | 004 41.315 |
| Osun | Obokun | Esun | 07 42.419 | 004 45.366 |
| Osun | Ilesa-East | College farm | 07 35.735 | 004 43.228 |
| Osun | Ede South | Olorogbo | 07 40.608 | 004 25.457 |
| Osun | Ede South | Awere-Alamo | 07 41.819 | 004 25.245 |
| Osun | Ede South | Awere-Alamo | 07 41.819 | 004 25.249 |
| Osun | Ede South | Ologobi Oja | 07 40.243 | 004 26.089 |
| Osun | Ede South | Olorubu | 07 40.802 | 004 25.640 |
| Osun | Atakumosa-West | Oloja Ibala | 07 43.728 | 004 35.068 |
| Osun | Atakumosa-West | Oloja Ibala | 07 43.107 | 004 35.453 |
| Osun | Osogbo | Oke-osun Farm Settlement | 07 44.604 | 004 31.752 |
| Osun | Egbedore | Ido-Osun | 07 47.959 | 004 29.657 |
| Osun | Egbedore | Ido-Osun | 07 49.603 | 004 31.865 |
| Ekiti | Ikole | Ipao | 07 59.230 | 005 36.031 |
| Ondo | Ile-oluji/Oke-Igbo | Agiodo | 07 10.680 | 004 51.521 |
| Ondo | Ile-oluji/Oke-Igbo | Gloryfield Rd | 07 12.134 | 004 51.197 |
| Ondo | Ile-oluji/Oke-Igbo | Farm Settlement | 07 14.121 | 004 51.651 |
| Ondo | Akure North | Km 5, Owo Rd. | 07 16.107 | 005 15.915 |
| Ondo | Owo | Otu land | 07 16.562 | 005 30.799 |
| Ondo | Owo | Iyana Otaago | 07 16.800 | 005 31.084 |

Contd.

| | | | | |
|---|---|---|---|---|
| Kogi | Ankpa | Acharana | 07 18.517 | 007 28.099 |
| Kogi | Bassa | Gboloko | 07 45.511 | 006 52.847 |
| Kogi | Bassa | Gboloko | 07 45.459 | 006 52.838 |
| Kogi | Dekina | Egume | 07 33.411 | 007 16.529 |
| Kogi | Dekina | Anyigba | 07 32.817 | 007 13.699 |
| Kogi | Dekina | Anyigba | 07 32.798 | 007 13.640 |
| Kogi | Dekina | Agada,Abocho | 07 35.843 | 006 51.773 |
| Kogi | Ofu | Ofagada | 07 03.471 | 007 06.478 |
| Kogi | Okene | Ere | 07 32.141 | 006 08.877 |
| Kogi | Okene | Ageva | 07 31.728 | 006 10.026 |
| Kogi | Okene | Oguda | 07 21.584 | 006 22.334 |
| Kogi | Okene | Oguda | 07 22.053 | 006 22.776 |
| Kogi | Adavi | Osara | 07 37.972 | 006 24.100 |
| Kogi | Okene | Osara | 07 37.799 | 006 23.915 |
| Kogi | Mopamuro | Amuro | 08 09.443 | 005 55.405 |
| Kogi | Yagba West | Ejiba | 08 16.564 | 005 39.676 |
| Kogi | Yagba West | Ejiba | 08 17.468 | 005 39.221 |
| Benue | Otupko | Upu | 07 13.880 | 008 10.708 |
| Benue | Otupko | Otobi | 07 05.326 | 008 07.421 |
| Benue | Otupko | Otobi | 07 05.457 | 008 07.362 |
| Benue | Otupko | Otobi | 07 06.909 | 008 06.188 |
| Benue | Otupko | Otukpicho | 07 16.774 | 008 11.648 |
| Benue | Konshisha | Mpav | 07 20.034 | 008 38.866 |
| Nasarawa | Kokona | Maisauri | 08 50.139 | 007 57.634 |
| Nasarawa | Karu | New Karshi | 08 51.691 | 007 35.289 |
| Nassarawa | Nassarawa Eggon | Ubbe | 08 52.581 | 008 25.530 |
| Nassarawa | Wamba | Wayo | 08 51.158 | 008 37.113 |

Table 2. Analysis of variance for number of plant, total fresh root, fresh root yield (t/ha) and rotted roots (%) for 29 varieties of cassava in farmer's fields in 7 States

| | | Number of plants | | Total fresh roots | | Fresh root yield (t/ha) | | Rotted root (%) | |
|---|---|---|---|---|---|---|---|---|---|
| Source | DF | Mean Square | Pr>F | Mean Square | Pr>F | Mean Square | Pr>F | Mean Square | Pr>F |
| State | 6 | 349 | 0.004 | 14874 | 0.005 | 446 | 0.011 | 248 | 0.001 |
| Rep(State) | 7 | 36 | 0.410 | 1601 | 0.401 | 63 | 0.358 | 14 | 0.998 |
| Variety | 28 | 123 | <.0001 | 5147 | <.0001 | 208 | <.0001 | 633 | <.0001 |
| State*Variety | 21 | 108 | <.0001 | 1861 | 0.244 | 127 | 0.003 | 343 | 0.000 |
| Error | 154 | 35 | | 1529 | | 57 | | 131 | |
| Total | 216 | | | | | | | | |
| R-Square | | 0.643 | | 0.516 | | 0.559 | | 0.597 | |

recommended spacing during planting but responded differently, based on need and land availability. The number of plants within the examined quadrat ranged from 8 in Powerline to 41 in Akpofafa, while the total root number ranged from 60 in Pakidudu to 218 in Akpofafa; all are local varieties (Table 3). The varied plant population and root number within the quadrat suggest that farmers' economic interest accounts for the variability. We observed that some farmers partially mechanized their farming operations by plowing their fields before planting; others used local heaps. Also, while some farmers planted cassava as a sole crop, others intercropped and this largely affected the plant population and invariably the root number. Furthermore, the age of the crop, the variety, the soil structure, the soil fertility, and environmental conditions during growth will greatly determine the number of roots harvested. The state × variety interaction was highly significant (Table 2) for the number of plants, indicating that farmers did not plant the same way in each State. There was no significant interaction for total root number, suggesting that the majority of the varieties reacted similarly in terms of the total root number in those States.

Table 3 shows fresh root yield (t/ha) and rot (%) for each of the varieties. The fresh root yield (t/ha) differed (*P≤0.05*) significantly among the States and within the varieties. This shows that the varieties responded differently to local environmental conditions, soil fertility, and management practices by farmers in each State. Fresh root yield ranged between 5 t/ha in Bendel and 52 (t/ha) in Abutu, and the grand mean was 18.3 t/ha. Both are local varieties. We observed that the exceptional yield of Abutu could be due to specific location adaption and the length of time it has stayed on the field. On average, we observed that improved varieties still performed better in term of fresh root yield (18 t/ha) than the local varieties (16.2 t/ha) (Table 3). Though this performance of improved varieties over local varieties looks marginal, when we consider that improved varieties mature faster than the local varieties, it would be evident that the turnover could be larger than as shown here. Furthermore, there was a significant difference (*P≤0.05*) in State × variety interaction for fresh root yield. This is a response to differential management practices, soil fertility, environmental conditions, and type of varieties that are available within a State as these conditions are not homogenous. The highest fresh root yield was recorded in Oyo State (20 t/ha), followed by Kogi and Benue States with 19 t/ha. The lowest yield was recorded in Ondo State with 9 t/ha (Fig. 1). This confirms previous common knowledge that the three States have a favorable environment for root and tuber crops. A lot of farmers grow cassava in these

Table 3. Varietal mean performance for number of plants, total fresh roots, fresh root yield (t/ha) and rotted roots (%).

| Variety | No of plant | Total fresh roots | Fresh root yield (t/ha) | Rotted root (%) |
|---|---|---|---|---|
| 91/02324 | 20.4 | 119.4 | 20.7 | 13.0 |
| 92/0057 | 25.0 | 132.5 | 24.9 | 14.0 |
| 92/0326 | 20.3 | 108.7 | 10.4 | 37.1 |
| 95/0289 | 21.8 | 96.0 | 20.0 | 19.2 |
| 96/1632 | 25.4 | 114.8 | 17.7 | 26.5 |
| 97/2205 | 35.0 | 161.0 | 35.1 | 0.0 |
| 98/0505 | 22.8 | 99.3 | 18.2 | 26.6 |
| 98/0510 | 15.2 | 77.5 | 17.3 | 29.2 |
| 98/0581 | 25.5 | 111.8 | 16.5 | 23.5 |
| Aba-Iyawo | 21.0 | 70.5 | 15.6 | 0.5 |
| Abutu | 22.0 | 190.0 | 52.2 | 0.0 |
| Ademola | 19.0 | 88.0 | 17.3 | 1.0 |
| Akata | 23.0 | 77.5 | 12.2 | 3.5 |
| Akpofafa | 41.0 | 218.5 | 31.3 | 0.5 |
| Arubielu | 9.5 | 84.0 | 14.0 | 0.0 |
| Atududu | 20.0 | 95.3 | 7.7 | 0.0 |
| Bendel | 18.5 | 71.0 | 5.4 | 2.8 |
| Ege-dudu | 14.5 | 111.5 | 17.6 | 0.7 |
| Ichenke | 34.0 | 97.5 | 19.8 | 0.0 |
| M98/0068 | 25.0 | 143.0 | 14.2 | 35.1 |
| Mokosooku | 18.5 | 150.5 | 17.4 | 1.0 |
| NADP | 30.0 | 160.8 | 20.9 | 0.4 |
| Odongbo | 15.3 | 66.6 | 14.7 | 1.9 |
| Oko-iyawo | 19.1 | 116.3 | 16.1 | 3.1 |
| Pakidudu | 16.0 | 60.0 | 10.8 | 0.0 |
| Powerline | 7.5 | 72.0 | 13.4 | 1.5 |
| TME419 | 21.0 | 117.0 | 19.9 | 10.8 |
| TMS30572 | 16.7 | 103.8 | 16.6 | 1.0 |
| Local | 28.0 | 133.7 | 14.1 | 1.8 |
| **Mean** | 21.8 | 112.0 | 18.3 | 8.8 |
| **SE** | 1.3 | 7.0 | 1.7 | 2.2 |
| | | | | |
| **Improved varieties** | 20.1 | 110.8 | 18.0 | 11.1 |
| **Local varieties** | 19.8 | 106.8 | 16.2 | 2.0 |

States because the environmental conditions, and soil structure favour production. More of the farmers grow lots of improved cassava and this accounted for the high yields recorded in their farms, especially by those farmers who received both improved varieties and agronomic training from IITA.

There were also significant differences (*P≤0.05*) in rotted roots (%) between the States and within the varieties and also State x variety interaction. Rotted roots ranged from 0 % in six varieties (97/2205, Abutu, Arubielu, Atududu, Ichenke, and Pakidudu) to 37 % in 92/0326 (Table 3). We observed that the high level of rot observed on improved varieties was largely due to the length of time they had stayed on the field (age of the crop) and the excessive rainfall experienced during the 2010 cropping season which made some fields waterlogged. Previous reports also associated rots with water logged fields (CTA 2008). This underscores the need for farmers to plant on soil that is well drained that would not retain water. Soils prone to waterlogging require the use of high ridges or mounds.

Although waterlogged fields could also limit the production of local varieties these seem to be more tolerant than the improved varieties. However, the ability of the local varieties to stay for 2-3 years longer on the field than the improved varieties suggest that they possess heritable characteristics that can be incorporated into the high yielding improved varieties. Therefore, there is need for cassava breeders to look at these quality traits in local varieties and incorporate some in the improved varieties for better performance. We also observed that more rots were recorded in Kogi (10%) and Oyo States (8%), with Nasarawa State having the least rot (0.2 %) (Fig. 1). The high level of rots recorded in Kogi State was largely due to heavy rain recorded in 2010 which made most field waterlogged, especially at Ejiba, Yagba West LGA. Likewise in Moniya, Akinyele LGA in Oyo State most of the samples of improved varieties were rotted due to their long duration on the field.

Although the frequency of occurrence of associated fungi was not directly measured, we were able to isolate fungi on some of the randomly selected rotted

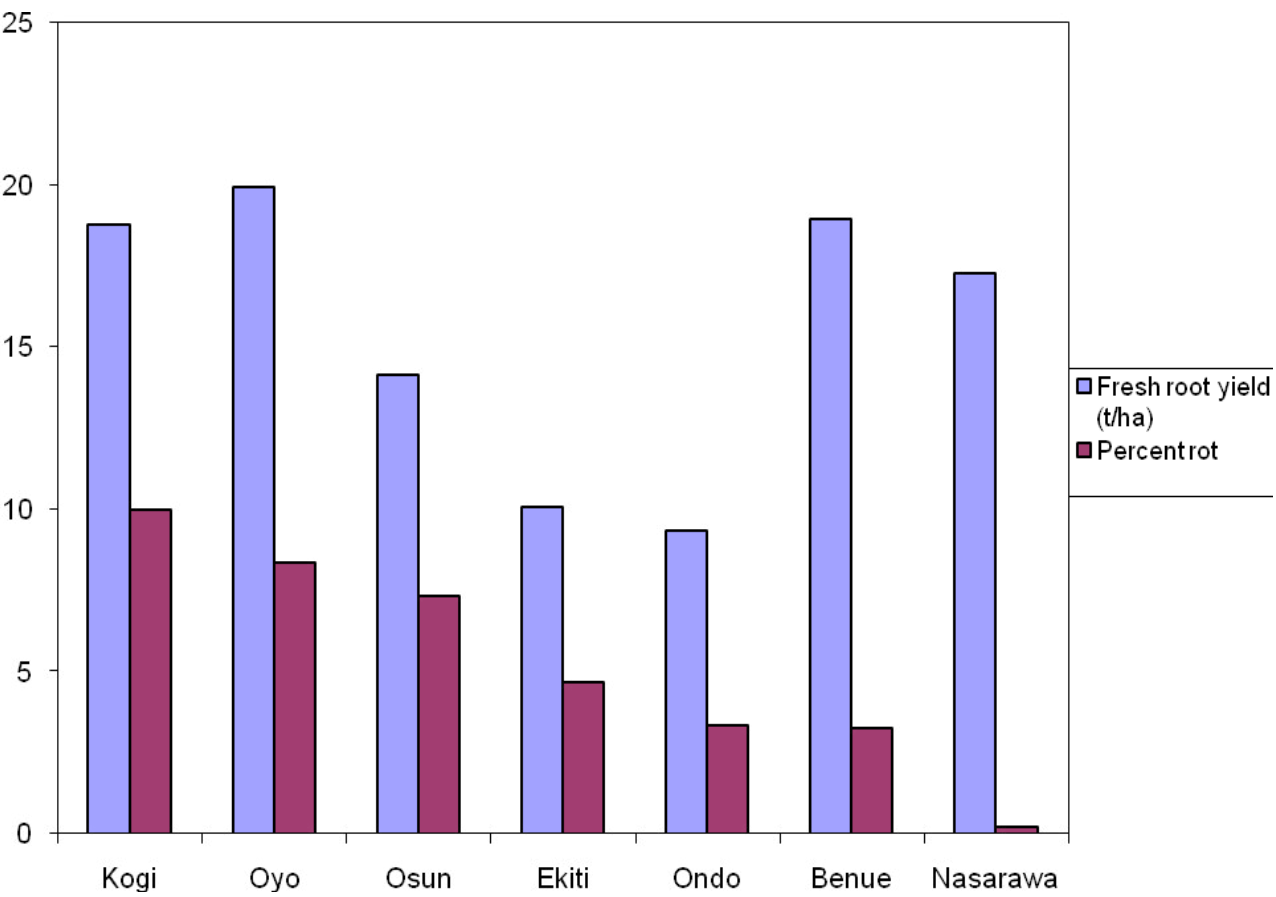


Fig. 1. Fresh root yield (t/ha) and rotted root (%) in seven States of Nigeria.

roots. This was due to the condition of most of the samples and the duration of the survey, coupled with the fact that it was not part of the focus of this study and has been dealt with by several investigator. However, the commonly isolated fungi were *Botryodiplodia theobromae, Fusarium oxysporum, F. solani, Aspergillus niger, A. flavus, Sclerotium rolfsil, Armilleria melea,* and *Trichoderma* species. The most prevalent pathogen on the samples across the seven States remained *B. theobromae*. Previous reports have associated these pathogens were cassava root rot disease in Nigeria (Onyeka 2002; Onyeka et al. 2004; Bandyopadhyay et al. 2006). Pathogens gain entrance to the roots through wounds created by man and other root knot microbes especially nematodes.

In conclusion, improved varieties of cassava have a promising potential in achieving food sufficiency if losses from root rot could be adequately reduced. Emphasis should be made by the breeders on improving the tolerance level of the improved varieties to root rot, waterlogging, and resistance to pathogen stress. Farmers should also be encouraged to cultivate more of the improved varieties and harvest them early to enjoy the added yield.

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