Tropical Root Crops

PRODUCTION AND USES IN AFRICA

Proceedings of the National Symposium
National Society of Root Crops —
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The International Society for Tropical Root Crops — Africa Branch was created in 1978 to stimulate research, production, and utilization of root and tuber crops in Africa and the adjacent islands. The activities include encouragement of training and extension, organization of workshops and symposia, exchange of genetic materials, and facilitation of contacts between personnel working with root and tuber crops. The Society’s headquarters are at the International Institute of Tropical Agriculture in Ibadan, Nigeria, but its executive council comprises eminent root and tuber researchers from national programs throughout the continent.

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Microfiche edition available.
Il existe également une édition française de cette publication.
TROPICAL ROOT CROPS: PRODUCTION AND USES IN AFRICA
ABSTRACT

A mixture of original research, updates on procedures, literature reviews, and survey reports, this document resulted from the second symposium of the International Society for Tropical Root Crops — Africa Branch, with 77 participants from 16 countries. The focus was cassava, yams, cocoyams, and sweet potatoes, from the perspectives of breeders, agronomists, soil specialists, plant pathologists, entomologists, nutritionists, food technologists, etc. Learning from past successes and failures, many of the researchers directed their efforts toward problems obstructing progress in reaching improved production and use of root crops and attempted to view, realistically, the context in which their results would be applied.

RÉSUMÉ

Résultats de recherches récentes, mises à jour sur les méthodes de recherche, revues de publications et rapports de sondages sont contenus dans ce document issu du Deuxième symposium de la Société internationale pour les plantes-racines tropicales — Direction Afrique, qui a réuni 77 participants de 16 pays. Des communications sur le manioc, le taro, le yam et la patate douce ont été présentées par des phytoselecteurs, des agronomes, des pédologues, des phytopathologistes, des entomologistes et des spécialistes de la nutrition et des aliments, entre autres. Tirant leçon de leurs succès et de leurs échecs, beaucoup de ces chercheurs ont dirigé leurs efforts vers la solution des problèmes qui entravent l’augmentation de la production et de la consommation des plantes-racines et ont tenté de considérer d’un œil réaliste le contexte qui sera celui de l’application de leurs recherches.

RESUMEN

Una mezcla de investigaciones originales, actualizaciones de procedimientos, reseñas de literatura e informes de encuestas, este documento es el resultado del segundo simposio de la Sociedad Internacional de Raíces Tropicales, Filial Africana, que contó con 77 participantes de 16 países. El simposio se centró en la yuca, el yame, el cocoyame y las batatas, desde la perspectiva de los fitomejoradores, los agrónomos, los especialistas en suelos, los patólogos vegetales, los entomólogos, los nutricionistas, los tecnólogos alimenticios, etc. A partir de los éxitos y fracasos anteriores, muchos de los investigadores encaminaron sus esfuerzos hacia los problemas que obstaculizan el avance para lograr una producción y un uso mejorados de las raíces y trataron de obtener una visión realista del contexto en que los resultados pueden ser aplicados.
TROPICAL ROOT CROPS:
PRODUCTION AND USES IN AFRICA

EDITORS: E.R. TERRY, E.V. DOKU, O.B. ARENE, AND N.M. MAHUNGU

PROCEEDINGS OF THE SECOND TRIENNIAL SYMPOSIUM OF THE INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS — AFRICA BRANCH HELD IN DOUALA, CAMEROON, 14 – 19 AUGUST 1983
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GENETIC PARAMETERS OF CASSAVA

N.M. MAHUNGU, H.R. CHHEDA, S.K. HAHN, AND C.A. FATOKUN

We investigated six diverse cassava populations grown during 1979–80 and 1980–81 at the International Institute of Tropical Agriculture (IITA), Ibadan, to estimate genetic parameters for 22 traits of cassava. The data, when analyzed, revealed that considerable variation existed both within and between the populations for most of the characters; the coefficients of variation for phenotype and genotype were largest for root yield (85% and 62%, respectively), quite large for the roots per plant and root size (60% and 40%, respectively), moderate for harvest index and total number of branches (45% and 30%, respectively), and low (less than 30% and 15%) for stem girth, canopy width, and plant height at harvest. Heritability estimates as well as expected genetic gain also varied considerably. On average, root yield and number of roots showed moderately high heritability (50%) and high expected response to selection (88% and 64%, respectively). Relatively high heritability values were obtained for harvest index (49%) and dry-matter content (52%), but they were associated with expected genetic gains of only 50% and 29%, respectively. Agronomic traits such as stem girth, canopy width, and plant height at harvest showed moderate-to-low heritability values (32–42%) associated with low expected genetic advance (15–18%).

Cassava breeding programs have been primarily based on selection for yield and have not included physiological or morphological characters in selection procedures. It would, therefore, be useful to have a quantitative statement of the relative importance of heredity and environment in determining the expression of characters.

In asexually reproduced plants, like cassava, any combination of genetic factors that yields a superior genotype can be used through clonal propagation. In such circumstances, all genetic variability can be used and heritability estimates have meaning (Hanson 1963).

This study was initiated to estimate certain genetic parameters of various cassava traits. Heritability is in most cases taken as a valid statistic for describing the relative variability inherent in a character and must represent a practical concept to have utility in plant breeding. The expected response to selection under a particular selection scheme supplies the practical information the breeder desires, and heritability estimates provide important information regarding advances that may be expected from selection. High heritability indicates that selection of desirable genotypes on the basis of phenotypic performance is likely to be effective.

MATERIALS AND METHODS

We conducted two separate field studies using different cassava populations at the International Institute of Tropical Agriculture (IITA), Ibadan. One, conducted during the 1979 growing cycle, utilized two genetically broad-based composites — A from African sources and B from Latin America and India, 45 and 42 genotypes, respectively. The other study conducted during the 1980 growing cycle, utilized mature cuttings of seedlings from four segregating F1 families produced from crosses between Isunikankiyan × 58308 (35 offspring), TMS 30395 × Isunikankiyan (35 offspring), 58308 × 60506 (25 offspring), and 60506 × TMS 30395 (20 offspring). Both studies were harvested at 12 months; the experimental design was a randomized complete block, with four replications. In each replication, for each genotype, four stem cuttings were planted in single rows, 1 m × 1 m. Observations were made on 22 traits.

Coefficients of variation (CV — %) were com-
<table>
<thead>
<tr>
<th>Character</th>
<th>A</th>
<th>B</th>
<th>Families from</th>
<th>Mean</th>
</tr>
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<tr>
<td></td>
<td>PCV</td>
<td>GCV</td>
<td>PCV</td>
<td>GCV</td>
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<td>88.50</td>
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<tr>
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<td>72.17</td>
<td>99.90</td>
<td>68.99</td>
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<tr>
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<td>29.41</td>
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<td>13.16</td>
<td>8.22</td>
<td>15.84</td>
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</tr>
<tr>
<td>HCN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roots</td>
<td>40.02</td>
<td>33.79</td>
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<tr>
<td>Leaves</td>
<td>28.90</td>
<td>15.97</td>
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<tr>
<td>Nodes/stand</td>
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<td>38.80</td>
<td>31.60</td>
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<tr>
<td>Flowering</td>
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<td></td>
<td></td>
<td></td>
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<td>12.49</td>
<td>30.13</td>
<td>24.84</td>
</tr>
<tr>
<td>Height</td>
<td>33.09</td>
<td>22.68</td>
<td>39.55</td>
<td>31.13</td>
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<tr>
<td>Resistance</td>
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<td></td>
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<tr>
<td>CMD</td>
<td>34.88</td>
<td>24.78</td>
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<td>22.81</td>
</tr>
<tr>
<td>CBB</td>
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<td>21.70</td>
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<td>16.52</td>
<td>8.47</td>
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<td>8.16</td>
</tr>
<tr>
<td>Canopy width</td>
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</tr>
<tr>
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<td>38.60</td>
<td>24.40</td>
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<tr>
<td>Stems/stand</td>
<td>39.93</td>
<td>17.86</td>
<td>47.11</td>
<td>23.11</td>
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</tbody>
</table>
Table 2. Broad-sense heritability ($h^2$) in % and expected response to selection ($R$) (% of mean and $i = 5\%$) of cassava traits in six cassava populations.

<table>
<thead>
<tr>
<th>Character</th>
<th>A</th>
<th>B</th>
<th>Isun. × 58308</th>
<th>30395 × Isun.</th>
<th>58308 × 60506</th>
<th>60506 × 30395</th>
<th>Average</th>
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<td>$R$</td>
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<td>$R$</td>
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<td>$R$</td>
<td>$h^2$</td>
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<td>106.56</td>
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<td>117.65</td>
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<td>Roots/plant</td>
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<td>109.03</td>
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<td>39.43</td>
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<td>105.68</td>
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<td>18.17</td>
<td>38.27</td>
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<td>34.60</td>
<td>12.69</td>
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<td>Nodes/plant</td>
<td>61.10</td>
<td>43.24</td>
<td>71.22</td>
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<td>Canopy width</td>
<td>20.30</td>
<td>8.61</td>
<td>19.26</td>
<td>8.03</td>
<td>32.92</td>
<td>13.34</td>
<td>5.74</td>
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<tr>
<td>1st forked branches/stand</td>
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<td>44.08</td>
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<td>21.58</td>
<td>32.08</td>
<td>22.73</td>
<td>46.15</td>
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</table>
computed as suggested by Burton (1952): 100σ/\bar{X}
where σ is the standard deviation and \bar{X} is the
mean of the trait. Broad-sense heritability (h²)
was estimated as h² = σ²g/σ²p where σ²g is the
genotypic variance and σ²p is the phenotypic
variance (Allard 1960). Response to selection
(R) was predicted as i\bar{h}σp where i is the stan-
dardized selection differential at 5%, h² is the
heritability, and σp is the phenotypic standard
deviation.

RESULTS AND DISCUSSION

Among the various characters studied (Tables
1 and 2), root yield, on average, had the largest
phenotypic and genotypic CV (85% and 62%
respectively); dry matter in roots and angle of
second forking branches had the least phe-
notypic (about 13%) and genotypic (9% and 8%
respectively) CV. Although phenotypic CV for
root size (64%) was somewhat higher than that
for number of roots (60%), the opposite was true
for genotypic CV. The phenotypic and ge-
tonotypic values were smaller for stem girth (18%
and 12% respectively); plant height at harvest
(18% and 11% respectively); and canopy width
(28% and 15% respectively).

Heritability and genetic advance for the dif-
ferent characters studied varied considerably
(Table 2). Moderately high heritability associ-
ated with high genetic advance was observed for
root yield, number of roots/plant, and branching
height in most of the populations. Aggarwal and
Kang (1976) observed high genetic gain associ-
ated with high heritability values for some char-
acters in horse gram and postulated additive
gene control for these characters. Additive
genes are probably also operating in cassava for
such traits, and, consequently, direct selection,
applied on the traits, can be expected to produce
worthwhile results.

Moderate-to-high heritability in characters
such as plant height at flowering, number of days
to flowering, harvest index, resistance to cassava
mosaic disease, and dry matter in roots was asso-
ciated with relatively lower genetic gain, indicat-
ing a somewhat limited scope for further
improvement by selection. The low expected
genetic gain for these characters, despite their
high heritability, mainly reflected their low ge-
tonotypic CV. Some characters such as stem girth,
plant height at harvest, and canopy width had
low heritability values associated with low ex-
pected genetic gain. A large proportion of the
variability observed in these traits was caused by
environment.

Root size showed fairly low heritability
(35%), with a sizable expected genetic gain of
47%, indicating the possibility of significant pro-
gress in improvement through selection and sup-
porting the findings from another study at IITA
in which heritability for root size was estimated
to be 37% (IITA 1975).

The additive portion of the genotypic variance
for some of the characters may be small, but this
possibility is not important if selection is being
done on clonal material because the nonadditive
portion can be fixed vegetatively (Hanson 1963).
As genetic advance in cassava is measured by the
potential of clonal types, estimation of
heritability as in this study could be quite useful
for plant-breeding programs.