Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

Proceedings of the First Triennial Root Crops Symposium of the International Society for Tropical Root Crops ~ Africa Branch
TROPICAL ROOT CROPS:
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PARAMETERS FOR SELECTING PARENTS FOR YAM HYBRIDIZATION

OBINANI O. OKOLI

NATIONAL ROOT CROPS RESEARCH INSTITUTE, UMUDIKE, UMUAHIA, NIGERIA

White yam, Dioscorea rotundata, produces viable seeds and can, thus, be improved by hybridization. Results of studies on certain desirable attributes of parent cultivars are presented and discussed. Yam production and improvement will advance fastest when true seeds can be easily grown in farmers' fields. It is recommended that research shift toward finding nicking parents for yam production via true seeds.

Dioscorea rotundata, espèce d'igname blanche, donne des graines viables, ce qui la rend propre à l'amélioration par hybridation. Cette étude présente et discute les résultats des recherches sur divers caractères souhaitables chez les cultivars parents putatifs. On reconnaît que l'amélioration et la production d'ignames progresseront plus rapidement lorsque les semences pourront être produites chez le fermier même. Il est donc recommandé de diriger les recherches sur la mise au point de parents d'élite pour la production d'ignames par semences.

Most yams are grown in the humid tropics, especially in Africa, Southeast Asia, India, and the Caribbean islands. Nigeria's yearly production is estimated at 1.5 Mt, about 75% of West Africa's production of the crop. Dioscorea rotundata (white yam) is the preferred species in many parts of West Africa, although a few other edible species are planted. White yam is believed to be indigenous in the area stretching from Ivory Coast through Ghana, Togo, Benin Republic, Nigeria, and Cameroon.

Yam improvement over the years has been by selection of "good" tubers by farmers planting new crops. As a result, "good adapted" cultivars have been selected for the different yam cultivation niches. Martin et al. (1975), based on their findings, suggested "poor distribution of the better varieties and the consequent use of inferior types in many regions that would not be used if better varieties were known." However, they recognized that yield reductions might be caused by viruses and diseases if interregional introduction of cultivars were adopted. Although flowering and seed set had been recognized in some species of yam, breeding by hybridization, especially in D. rotundata was hampered by poor seed set, low seed viability, and the small size of tubers produced from true seeds (Waitt 1961). The work of Sadik and Okereke (1975b) and Okoli (1975) in germinating true seeds of D. rotundata has renewed interest in the possibilities of improving yams by hybridization.

This paper reports some of the work that had to be done so that meaningful hybridization schemes could be evolved.

IMPROVEMENT OBJECTIVES

Summarizing yam breeding objectives, Wilson (1978) indicated the need to breed cultivars "which have all the conventional attributes of high yield, disease and pest resistance, storability and culinary quality. In addition, they must possess characters which lower the labour requirements, eliminate staking and reduce the amount of planting material required."

Planting yams by means of true seeds is a producer's dream and should become an important breeding objective. Thus, producing parents whose seeds will, in the first year after being planted, yield good-sized and well-shaped tubers will mark the end of efforts to begin constructing ideal parents for yam improvement.

IMPORTANT CHARACTERISTICS FOR PARENTS

LOW SEED TO YIELD RATIO

The cost of seed yams, estimated at one-third the total outlay of yam production (Nwosu 1975), has been identified as a major constraint to increased yam production. Okoli (unpublished) assessed the input:output relationships in different cultivars of yam species for a 3-year period (Table 1).
Table 1. Average "seed" : yield ratio of yam cultivars planted at Umudike for "seed" and for sale as food.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>&quot;Seed&quot; yam production</th>
<th>Food yam production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planted (kg/ha)</td>
<td>Harvested (kg/ha)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. rotundata,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nwapoko</td>
<td>2.8</td>
<td>14.2</td>
</tr>
<tr>
<td>Ekpe</td>
<td>1.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Abi</td>
<td>1.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Obiaoturugo</td>
<td>2.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Okwocha</td>
<td>2.1</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. cayenensis, Oku</td>
<td>1.8</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. alata,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oku</td>
<td>1.9</td>
<td>9.2</td>
</tr>
<tr>
<td>Ominaelu</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. dumetorum, Ona</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Planted (kg/ha)</th>
<th>Harvested (kg/ha)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. rotundata,</td>
<td>2.8</td>
<td>16.5</td>
<td>3.51</td>
</tr>
<tr>
<td>Nwapoko</td>
<td>1.7</td>
<td>6.2</td>
<td>4.13</td>
</tr>
<tr>
<td>Ekpe</td>
<td>1.7</td>
<td>8.5</td>
<td>2.93</td>
</tr>
<tr>
<td>Abi</td>
<td>2.2</td>
<td>12.3</td>
<td>5.42</td>
</tr>
<tr>
<td>Obiaoturugo</td>
<td>2.1</td>
<td>10.0</td>
<td>4.55</td>
</tr>
<tr>
<td>Okwocha</td>
<td>1.8</td>
<td>10.8</td>
<td>2.40</td>
</tr>
<tr>
<td>D. cayenensis, Oku</td>
<td>1.9</td>
<td>15.4</td>
<td>5.70</td>
</tr>
<tr>
<td>D. alata,</td>
<td>1.9</td>
<td>13.5</td>
<td>6.75</td>
</tr>
<tr>
<td>Ominaelu</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>D. dumetorum, Ona</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Many workers have reported on the relationships between "seed" planted and the harvest yield. Although it is known that larger seed pieces (and hence larger seed input per hectare) sprout more readily, produce more vigorous plants, and yield more per plant than do smaller pieces, the desirable size for seed pieces remains controversial.

The observed relationship between the total weight planted and that harvested in the various varieties of yam has significance in yam hybridization programs. Varieties having more favourable input:output ratios are more attractive for use as parents in hybridization programs than are those having larger ratios even when yields of the different varieties are the same.

MINIMUM OR NO STAKING REQUIREMENTS

Staking is another major cost item in yam production. Although in the Guinea savanna regions of Nigeria, yams are not usually staked, farmers know that such yams as find support invariably yield better than those crawling on the mounds. In studies on the effect of staking height on the yield of yams, it was found that the height of stakes beyond 2 m does not significantly increase yield of yams (Okigbo 1973). Apart from being expensive, tall stakes obstruct farm machinery used for weeding or harvesting the yams. In a 2-year study to evaluate the yields of eight yam cultivars from three species, it was shown that in some cultivars, staking makes only marginal differences to overall yield. Thus, although yields of two varieties of yams may be similar when staked, the variety with the smaller difference between unstaked and staked yields is preferable as a parent in a hybridization program (Table 2).

EFFICIENT DRY-MATTER DISTRIBUTION TO TUBERS

Yam stores most of its photosynthates in underground parts called tubers. The proportion of total photosynthates stored in the tubers as against those found in inedible parts varies among species and among varieties of the same species. In a study of

Table 2. Unstaked : staked yield ratios in yam cultivars at Umudike.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>1978</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. rotundata,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nwapoko</td>
<td>1:1.193</td>
<td>1:1.219</td>
</tr>
<tr>
<td>Obiaoturugo</td>
<td>1:1.159</td>
<td>1:1.147</td>
</tr>
<tr>
<td>Ekpe</td>
<td>1:1.021</td>
<td>1:1.255</td>
</tr>
<tr>
<td>Okwocha</td>
<td>1:1.479</td>
<td>1:1.20</td>
</tr>
<tr>
<td>Abi</td>
<td>1:1.143</td>
<td>1:1.281</td>
</tr>
<tr>
<td>D. alata,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ominaelu</td>
<td>1:1.174</td>
<td>1:1.716</td>
</tr>
<tr>
<td>UM 680</td>
<td>1:1.384</td>
<td>1:0.49</td>
</tr>
<tr>
<td>D. dumetorum, Ona</td>
<td>1:1.0</td>
<td>1:1.095</td>
</tr>
</tbody>
</table>

164
the rate of dry matter accumulation and partition in four yam varieties from two species, Okoli (1980) found an inverse relationship between total yield and the proportion of total dry matter allocated to the tubers. That is, low-yielding cultivars allocated a higher proportion of the dry matter produced to the tuber than did higher-yielding cultivars. Thus, in a hybridization scheme, using physiologic (partition) efficiency as an index for selection of parents might lead to faster progress in yield improvement than using such complex indices as yield.

ADAPTATION TO ENVIRONMENT

Yam cultivars are known to be particularly selective of their growth ecology — soils, rainfall regimens, daylength, etc. D. rotundata cv. Ekpe is an early maturing yam commonly planted in the alluvial soils of the Anambra flood plains of South-east Nigeria. Yields under local cultural practices reach 15–20 t/ha. In the sandy loam soils of Umudike, however, the Ekpe cultivar hardly yields up to 5 t/ha, although it remains early maturing.

In yield trials of eight cultivars from two yam species over a 3-year period at Umudike, Okoli (unpublished) showed that the two highest-yielding cultivars of D. rotundata — Nwapoko and Obiaoturugo — and the Um 680 cultivar of D. alata can be recommended for this area. However, Nwapoko does not flower in this environment and, therefore, cannot be considered in the development of parents for seed-grown yams.

CONSISTENT AND PROFUSE FLOWERING

Yams are mostly dioecious, although some cultivars do not ordinarily yam and others have both staminate (male) and pistillate (female) flowers on the same plant. There is, however, a preponderance of staminate inflorescence (141 males and 106 females) in the germ plasm collection at the National Root Crops Research Institute (NRCRI) in Nigeria, which includes 900 accessions. In selected farmers’ fields near Umudike, the ratio is approximately 4 staminate : 1 pistillate : 2 nonflowering cultivars.

It appears that the size of sett planted affects flowering in pistillate plants but only the profuse ness of flowering in staminate plants. In the planting of yams desired for hybridization, therefore, large tubers rather than small setts should be used. Also, because of differences in the periods of floral initiation (staminate plants usually flower earlier), staminate plants should be planted at weekly intervals for 4 weeks so that pollen is available when pistillate inflorescences are receptive.

ABSENCE OF BROWNING IN TUBER FLESH

A criterion for selection of progenies used at late stages of yam breeding at NRCRI is the absence of browning of the tuber when cut and exposed to air. Browning results from oxidation of phenolic compounds present in the yam tuber.

The majority of tubers derived from seed have this browning tendency, which is rarely seen in cultivars being grown by farmers. Flesh colour of the cut and exposed tubers is scored 1 through 5, where 1 is dark brown and 5 is white. Clones scoring less than 3 are rejected.

VIABILITY OF SEEDS

Yams available for food will be increased by up to 30% when true seeds rather than tubers or tuber pieces are used by farmers planting new crops. The ultimate breeding objective, therefore, is to produce such pistillate and staminate cultivars that will nick and produce many viable seeds and whose seedlings will yield well-shaped, uniform, medium-sized tubers. That done, breeding for pest and disease resistance, long shelf-life, good culinary qualities, etc. become attractive objectives.

Obtaining other qualities without the means of transferring them by hybridization is almost valueless, as the good qualities cannot be multiplied quickly for distribution to farmers. Consequently, progenies that do not flower are rejected in the breeding program.

CONCLUSION

The varieties selected for use as parents in a yam hybridization program should reflect the breeding objectives. It is important to identify the attributes of ideal parents and to understand their behaviour in the anticipated growth environments and under the expected cultural management systems. If seed culture is to be adopted in at least some stage of yam production, flowering with profuse and viable seed production must be given a prominent place in yam improvement programs.