# YIELD TRIALS WITH *DIOSCOREA ALATA*

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Yams, Dioscorea species, are grown throughout the Caribbean area and are of varying importance in various territories. The collection and preliminary observation of nearly a hundred clones by H. J. Gooding indicated that there was an urgent need for reliable information on a number of characters of these yams, especially yield.

With this in view trials have been carried out over the last three years and this paper presents some of the results.

Although we have not yet obtained any seed of *D. alata,* and it may prove difficult to do so, a number of freely seeding clones of *D. trifida* are in our possession. It was also hoped therefore that a knowledge of character variations and their inter-relationships would be of use in the execution of future breeding programmes in *Dioscorea.*

## MATERIALS AND METHODS

### *Materials*

The materials used in these trials are six of the cultivars of the yam *Dioscored alata* collected by H. J. Gooding throughout the West Indian region between 1957 and 1960. During the period 1960 to 1963, the 98 cultivars of *Dioscorea* collected were put through preliminary observation, selection and multiplication, by H. J. Gooding here at St. Augustine.

The cultivars under trial were all of the Lisbon group of *Dioscorea alata* and appear to be very closely related although each is a recognizably different clone. The names obtained at the time of collection and their accession numbers and their place of origin are listed below :

| *Name* | *Accession No.* | *Place of Origin* |
|---|---|---|
| Ashmore | 03/59 | Grenada |
| Barbados | 14/57 | St. Vincent |
| Harper | 01/59 | Barbados |
| Oriental | 39/57 | Barbados |
| Seal Top | 33/60 | St. Croix |
| Smooth Statia | 02/60 | Dominica |

### *Methods*

In all trials four ounce sections of tuber were used as planting material and these were planted at 18-inch intervals along ridges three feet apart. All the trials were laid down in randomised blocks.

In 1964, the trial was planted on the 2nd of June, weeded by hand on the 15th of July and staked with bamboo poles on the 16th of July. The trial was first sprayed by mistblower with Cupravit at a concentration of one ounce per gallon on the 8th of September, and at fortnightly intervals thereafter, until the foliage was dry. The trial was reaped by hand and the records taken in the field on the 25th, 26th, 27th and 30th of November, and the 1st and 2nd of December.

In 1965, the trial was planted on the 14th day of June, and staked with wire and string on the 22nd of June. Spraying in the manner described for 1964 was started on the 15th day of July. Weed control was effected with Gramoxone and the trial was reaped on 14th December.

In 1966 the trial was planted on the 17th of May and staked on the 27th of June with wire and string. Spraying alternately with one ounce per gallon of Cupravit and half ounce per gallon of Zineb was carried out at weekly intervals starting on the 12th of July. Weeds were controlled with gramoxone and the trial was reaped on the 10th of January.

No fertilizers were applied to any of the trials and they were carried out at different points on the University Field Station at Champs Fleurs in Trinidad.

The variation in planting date is due to variation in the onset of the rainy season and in the sprouting of the yams. Reaping was carried out when all the foliage was dry and it is assumed that all cultivars are fully mature. The late reaping in 1966 may be attributed to better disease control and a late and wet dry season.

In 1964, eight replications of thirteen-eight-plant block and in 1965 five replications of thirteen-four-plant blocks, and in 1966 four replications of thirteen-four-plant blocks were planted.

A plant which had produced a tuber was recorded as having survived regardless of how small the tuber may have been. This was found to be necessary since records were taken after all the foliage had been removed along with the stakes or staking material to facilitate the accurate recording of individual plants.

Weights were recorded to the nearest quarter ounce and the tubers from all the surviving plants in a block were weighed together. There are therefore some instances where a plant is recorded as being present, but no weight of tubers is recorded.

A guard row of plants was planted around each replication and an extra guard row was planted on both windward sides of the whole experiment to minimise the effect of buffeting and premature drying out by the wind.

Wherever statistical significance is stated as being present and the level of probability is not stated it is the 0.1 per cent level which exists.

## RESULTS

Table I gives the means of the percentage stand at reaping, the yield in long tons per acre and in ounces per plant for the three years 1964, 1965 and 1966.

It may be seen that both survival and yield were depressed in 1965, the year in which there was an early and severe attack of a foliar disease caused by *Colletotricum*. In 1964 the disease built up much later in the growing period and was less severe in that it did not destroy the trials completely, the cultivar Oriental seeming to be the least affected. This may be due to this being the second year in which yams were grown on a reasonably large scale for some years. Yield in this year is on average midway between the yields in 1965 and 1966 while survival is approximately equal to that of 1966. In 1966, a greater knowledge of effective control measures and earlier and more intensified spraying effected considerable control of the disease and the yields are considerably higher. The variation between years in yields and survival may therefore be due mainly to differences in the intensity of disease attack.

It should be noted that the halving of the 1964 mean yield over all cultivars in 1965 and its doubling in 1966 are accompanied by only a 15 per cent reduction in survival and no significant change respectively.

Thus, even with a disease which often kills the entire crop, yield may be severely affected without affecting survival.

In 1964 and 1966 the yield of the cultivar Oriental was two to three and a half times higher respectively than Seal Top, the highest yielding of the other cultivars. The differences are statistically significant at the 0.1 per cent level of probability. In 1965, however, all cultivars were reduced to approximately the same level of yield presumably by the severe disease attack, and only the difference between the cultivar Ashmore and Oriental is statistically significant at the 5 per cent level.

This high yield in the cultivar Oriental is linked with a stand of 95 and 96 per cent at reaping which may be regarded as very close to the maximum attainable under field conditions. Although this survival is at least 20 per cent higher than any other cultivar it cannot entirely account for the greater yield.

Table II gives the coefficient of variation between plants and between replications and the degrees of freedom for the number of surviving plants and yield. Comparison of the coefficients of variation between plants for both parameters with the means for the corresponding parameters in table I shows that there is generally an inverse relationship both between cultivars and years. This is not surprising since variation tends to increase proportionally with the level of stress and yield may be expected to have an inverse relationship with stress. If yield is only limited by genetic potential then this argument does not hold, however, the presence of disease at various levels of intensity suggest that this is not the case.

In some years, in some cultivars the coefficients of variation are below or in the region of 40 per cent. This is sometimes regarded as an acceptable level of variation for field trials under tropical conditions. Thus, with care in the choice of cultivar and disease control, trials on other aspects may have few problems of a statistical nature.

The coefficients of variation between replications show relatively haphazard variation. Generally the years and cultivars with the highest yields and survivals show low between replication variances. These very large coefficients of variation are typical of trials where disease plays an important part. This particular disease appears to be spread by rain splashes and the crop is usually destroyed by the progressive extension of the centres of infection. It is probable that the patchy nature of the infections has led to these very high coefficients of variation.

These large variances and their very sporadic variation are reflected in seemingly meaningless series of variance ratios. It can only be suggested that the lack of significantly larger between replication variances in 1964 is mainly due to increased between plant variation and not to decreased overall variability.

Table III gives the coefficients for the correlations between number of surviving plants and yield for all cultivars in all three years.

All the correlation coefficients are statistically significant at the 0.1 per cent level except that for the cultivar Oriental in 1966 where it is significant at the 5 per cent level.

It may be noted that where the percentage survival and the correlated parameter yield are highest, the correlation coefficients are lowest. The converse is also true.

Values of correlation coefficients nearer to a half show a more haphazard relationship. These relationships suggest that other factors have a significant effect on the coefficients and these were either not measured or not measured with sufficient accuracy for the relationship to be clear. However, at the highest and lowest yields and survivals, the extreme nature of these parameters and their variances allows them to have an overriding effect.

Thus, the low and barely significant correlation shown by the cultivar Oriental in 1966 may be mostly due to the very low variance, especially in survival which is very close to being complete.

## DISCUSSION

It is very interesting to note the rather wide variation in yield and survival that has been recorded and to speculate on the possible causes and relationships between these and other parameters.

The general question of the relationship between yield, survival and the severity of disease attack can bear discussion. In every cultivar except Barbados, there were large and statistically significant reductions in yield that were not accompanied by similar reductions in survival. In the lowest yielding cultivars Ashmore, Harper and Smooth Statia, survival is reasonably constant in the two worst years 1964 and 1965, yield, however, is much lower in 1965. In the higher yielding cultivars Seal Top and Oriental, the very severe disease attack in 1965 reduces both survival and yield when compared with 1964, but the far more effective control of the disease in 1966 does not allow a survival significantly above that in 1964 although it allows a statistically significantly higher yield.

Bearing in mind that a plant is recorded as having survived if at least one tuber of any size is produced, variation in the date of tuber initiation may be the most important factor affecting survival in the presence of a foliar disease which usually builds up after a significant amount of foliage has appeared. Thus it would be very interesting to determine whether the three cultivars which do not show differences in survival under medium or severe disease attack initiate tubers early before the onset of the disease and thus meet the conditions for survival without necessarily having any real resistance to the disease.

Yield would thus be the character which would indicate resistance or tolerance, since tuber bulking should be curtailed in proportion to the severity of disease attack.

It will be recalled that all trials were reaped at full maturity of all cultivars. Thus, the extent of the period over which tubers are bulked may easily be the most important factor determining overall yield. This is not a novel suggestion and it would explain the low and similar yield of all cultivars in 1965 when the growing season was severely curtailed by disease. The similarity is particularly apparent in the number of ounces produced per surviving plant since survival is no longer a complicating factor. It would also explain the higher yield in 1966 given by Oriental and Seal Top at similar survivals to those shown in 1964.

It would be similarly interesting to determine whether the duration of tuber bulking is the same in all cultivars, and the factor which determines yield is the timing of tuber initiation. It may be that low yielding cultivars initiate tubers early when there is less foliage available for starch production, and the foliage dies back and bulking stops without ever having attained its full physiological potential. In high yielding cultivars, tubers may be initiated late and bulking may be far more rapid and thus more extensive in the same period, because of the more developed foliage. The early tuberizing low yielding cultivars would, however, have the advantage in survival under conditions of severe disease attack, and this may account for their continued existence.

The answering of these questions may well provide fruitful fields for future research and they would no doubt be as informative as they have been in other crops. They should also be of invaluable assistance to the planning of breeding programmes in this genus.

## SUMMARY

Trials over three years of six cultivars of the yam *Dioscorea alata* are described. Differences in the severity of disease attacks are suggested as a main cause of variation in yield in different years. The significantly high yielding cultivar Oriental shows no greater yields under severe disease attack.

*Table I*

| | Percentage Survival | | | | Yield in long tons per acre | | | | Yield in ounces per surviving plant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1964 Mean | 1965 Mean | 1966 Mean | Overall Mean | 1964 Mean | 1965 Mean | 1966 Mean | Overall Mean | 1964 Mean | 1965 Mean | 1966 Mean | Overall Mean |
| Ashmore | 55 | 52 | 63 | 57 | 1.23 | 0.83 | 3.53 | 1.86 | 8.3 | 5.9 | 20.8 | 11.7 |
| Barbados | 67 | 56 | 78 | 67 | 1.79 | 1.24 | 4.97 | 2.67 | 9.9 | 8.2 | 23.8 | 14.0 |
| Harper | 77 | 79 | 52 | 69 | 2.04 | 1.28 | 1.46 | 1.59 | 9.9 | 6.0 | 10.5 | 8.8 |
| Oriental | 95 | 64 | 96 | 85 | 7.55 | 1.29 | 11.21 | 6.68 | 29.6 | 7.5 | 43.4 | 26.8 |
| Seal Top | 68 | 55 | 69 | 64 | 2.21 | 1.13 | 5.28 | 2.87 | 12.1 | 7.6 | 28.3 | 16.0 |
| Smooth Statia | 58 | 56 | 68 | 61 | 1.52 | 1.08 | 3.85 | 2.15 | 9.7 | 7.1 | 20.3 | 14.7 |
| MEAN | 70 | 60 | 71 | 67 | 2.72 | 1.14 | 5.05 | 2.97 | 13.3 | 7.1 | 24.5 | 15.3 |

NOTE: 1 long ton per acre equals approximately 2.5 metric tons per hectare.

*Table II.*

| | Number of Plants | | | | | | Yield | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coefficient of Variation | | | | | | Coefficients of Variation | | | | | |
| | Between Plants | | | Between Reps. | | | Between Plants | | | Between Reps. | | |
| | 1964 | 1965 | 1966 | 1964 | 1965 | 1966 | 1964 | 1965 | 1966 | 1964 | 1965 | 1966 |
| Ashmore | 40 | 63 | 43 | 53 | 61 | 63 | 72 | 113 | 58 | 169 | 67 | 201 |
| Barbados | 28 | 59 | 25 | 56 | 76 | 45 | 67 | 107 | 49 | 145 | 156 | 138 |
| Harper | 26 | 25 | 49 | 41 | 48 | 152 | 70 | 87 | 80 | 190 | 184 | 237 |
| Oriental | 30 | 45 | 13 | 28 | 85 | 7 | 34 | 93 | 36 | 57 | 95 | 58 |
| Seal Top | 31 | 55 | 40 | 57 | 125 | 78 | 58 | 93 | 63 | 199 | 167 | 167 |
| Smooth Statia | 36 | 63 | 46 | 48 | 65 | 77 | 81 | 140 | 62 | 130 | 109 | 176 |

*Table III.—Correlation Coefficients.*

| | 1964 | 1965 | 1966 |
|---|---|---|---|
| Ashmore | 0.583 | 0.740 | 0.512 |
| Barbados | 0.579 | 0.757 | 0.618 |
| Harper | 0.584 | 0.429 | 0.773 |
| Oriental | 0.387 | 0.642 | 0.288* |
| Seal Top | 0.602 | 0.658 | 0.632 |

*All coefficients are significant at the 0 1 per cent level except that for Oriental in 1966 which is significant at the 5 per cent level.