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STUDIES ON THE GROWTH OF THE CHINESE YAM (Dioscorea esculenta) AND THE BELL YAM (Dioscorea trifida)

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INTRODUCTION

Little research work has been done with root crops in Guyana, and yams in particular have apparently had no attention for over a decade. However, the bell yam (Dioscorea trifida) is native to the South American continent and is widely grown in Guyana. Farmers use cultural techniques which are a part of very old traditions and get very poor yields. There seemed every justification, therefore, to embark upon work which would examine some factors that control growth and dormancy of yams. This paper reports on some of the preliminary work done to-date.

MATERIALS AND METHODS

Experiments were done with the chinese yam (Dioscorea esculenta) and the bell yam or cush-cush (Dioscorea trifida). Five treatments were replicated three times in a randomized block design. The treatments were as:

1. D. esculenta - small setts (50 - 109 gms)
2. D. esculenta - large setts (110 - 170 gms)
3. D. trififa - whole setts (whole tubers)
4. D. trifida - top setts (shoot end of tubers)
5. D. trifida - tail setts (bottom end of tubers)

The setts were planted on a ridged uniform mixture of sand, clay, loam, fibre dust and rotted sugar-cane filter-press mud. Spacing was 45 cms (18 ins) in rows 90 cms (3 feet) apart. Plot size was 3.6 metres x 7.8 metres (12' x 26') and guard rows surrounded the plots. Planting was done during the third week of June and an 11:11:33 fertilizer mixture was applied six weeks later at the rate of 500 kg/ha (4 cwt/acre). Plants were staked individually with 3 metre (10') bamboo sticks. A pre-emergence herbicide spray of Atrazine was applied at 3.4 kg/ha (3 lbs./acre) and subsequent control was affected by hand weeding. Dithane M-45 was sprayed on all plants at the rate of 2 tablespoons/gallon of water to control the spread of blcok lesions which appeared on the leaves of D. trifida some 3 months after planting.

Three plants were taken as samples from each plot at approximately monthly intervals, using a table of random numbers. Roots, shoots and tubers were immediately separated. Tubers were divided into two equal portions with the same distribution of sizes; one portion was used for fresh and dry weight determinations as were the entire root and shoot samples and the other portion was used for ascorbic acid measurements.

Total ascorbic acid was estimated by the dinitrophenylhydrazine (DNP) method of Roe & Oesterling (6). Each sample (representing 3 plants) was blended for about 10 seconds with 40 mls of cold 0.5% metaphorphoric acid for every gm of tissue. After 3 minutes of centrifugation at 0°C and 3,300 r.p.m. the supernatant was poured off and stored at 2°C until further manipulated. One aliquot of the supernatant was treated with acid-washed Norit, filtered then in triplicate was put through the DNP passes; this gave an estimate of total ascorbic acid. Another untreated aliquot was titrated in triplicate against dichlorophenolindophenol (DPIP) to give an estimate of reduced ascorbic acid (AA) The difference of course represented oxidized ascorbic acid (DHA). In all assays a freshly made standard of 0.1 mg AA/ml of 0.5% metaphosphoric acid was included; the AA was supplied by B.D.H. Ltd., who claimed 99.7% purity for their product.

RESULTS AND DISCUSSION

D. esculenta gave 99% germination irrespective of sett weight. However, as Fig. 1 shows large setts gave earlier shoot growth and tuber bulking than small setts. There was little detectable difference in root development between large and small sett plants, although the former appeared to give earlier root growth. These findings on shoot & tuber growth are in accord with those reported by Enyi (1) in Africa while this work was in progress. The results herein reported, however, do not suggest that large setts give higher final yield than small setts, although there is an indication that the former could possibly provide an earlier harvest if both are planted at the same time.

D. trifida unlike the chinese yam exhibited marked differences (statistically significant at 1% probability level) in germination depending on sett origin. Whole setts gave 81% germination compared to 67% for heads and 57% for tails the latter two apparently suffering from massive infection probably caused by cutting. Fig. 2 shows that although head setts had resulted in more shoot dry matter accumulation than wholes and tails had at 4 months after planting, shoot growth in tails subsequently outstripped both heads and wholes which were quite similar in growth pattern from 5 months onwards. Tuber development from tails was superior ti that from heads and wholes as their shoot development would lead one to expect; however, wholes appeared superior in tuber bulking to heads although there was little difference in their shoot growth after 5 months as previously observed. The results indicate that ability to germinate in these experiments was not associated with ability to accumulate dry matter; the tail setts gave best results in the latter respect but performed poorest in the former.

One relevant phenomenon observed was the late production of new spires, some 7-8 months after planting, at the time the old shoots began to die back. Possibly this or flowering observed at about the same time, occurred to a greater extent in the heeds than in wholes and caused a greater diversion of food materials that would normally have gone to production of tuber stores. The data on shoot moisture indicated a massive increase of fresh material in heads and little in wholes over this period. This could explain why the same shoot dry matter content in heads and wholes was associated with more tubers in wholes than in heads due to less diversion of assimilates in the former case.

Generally tuber weights at harvest were very low, 30-60 gms (1-2 ozs) dry weight per plant and this could possibly be related to two periods of flowering observed. The first peak was observed in November about 4 1/2 months after planting and coinciding with the commencement of tuber-bulking; the second phase had a peak in February about 7 1/2 months after planting which was in a period during which rapid tuber bulking normally occurs. Data giving details of flowering were unavailable but if the same plants flowered twice then much lower yields would be expected from them than from plants which only flowered either in November or February. Flowering in D. spiculiflora (4) is apparently dependent on a short daylength stimulus and if this is so for D. trifida early planting would probably increase yield by allowing more leaf area accumulation before flowering occurs in November and permitting a harvest before much flowering in February.

Ascorbic Acid Levels

The oxidized form of ascorbic acid (DHA) represented less than 5% of the total (AA + DHA) in almost all assays and, therefore, fluctuations here did not appear important. The levels of total ascorbic acid in all cases fell as tuber bulking proceeded and then increased again during the last phases of tuber maturation. Fig. 3 indicates that for D. esculenta higher levels existed in tubers of large sett plants than in those of small sett plants at 4 months after planting. However, at harvest plants from both types of material had similar levels. A connection between auxin level changes, ascorbic acid level changes and shoot and tuber growth seems probable. If one then invokes lowering of ascorbic acid levels as being associated with tuber development then the final upswing seen in Fig. 3 could be related to renewed shoot growth which was observed shortly before harvest; such regrowth could, like auxin and ascorbic acid levels, be associated with some environmental variable like photoperiod.

It is interesting to note in this connection that Garner and Allard (2) reported an inverse relationship between tuber yield and shoot growth for D. alata; short days were found to promote tuber growth in this species. Workers with vine cutting (3,5) also found similar relationships between daylength, shoot growth and tuber growth.

Changes in ascorbic acid levels in tubers of D. trifida generally followed a pattern similar to that observed for D. esculenta - see Fig. 4. It is, however, peculiar that the patterns for tail setts and whole setts were very similar and differed slightly from that for head setts where there seemed to be less variation; the reasons for this are obscure. Early shoot growth, flowering and subsequent renewed shooting must all be controlling factors with respect to tuber yield. Insufficient data on the latter two make it impossible to assess here possible differences in their effects on plants derived from different types of planting material. Further study of ascorbic acid and hormone changes through dormancy and growth will undoubtedly shed more light on the subject.

S U M M A R Y

Preliminary investigations were done into some factors that control the growth and dormancy of the chinese yam (Dioscorea esculenta) and the bell yam (Dioscorea trifida).

D. esculenta exhibited 99% germination irrespective of planting sett size. Small setts initially gave slower accumulation of dry matter in shoots and tubers than did large setts; both types of planting material resulted in the same average final tuber yield although large setts gave this yield earlier.

D. trifida exhibited 81% germination of whole tubers compared to 67% and 57% of head and tail setts, respectively. All setts were about the same weight and the differences which were statistically significant appeared to be caused by different rates of infection of the planting material. Differences in dry matter accumulation in shoots derived from different types of planting setts did not correspond to differences observed in the rate of dry matter accumulation in respective tubers; although the data is insufficient to clearly determine the causes of this phenomenon, observed differences in the extent of fresh shooting late in the growing season and possible differences in rate and frequency of flowering provide possible explanations.

Ascorbic acid levels for all yams fell as tuber bulking proceeded but rose again slightly at the end of the growth period. The observations fit the suggestion that the level of ascorbic acid in the tuber is related to the rate of tuber and shoot growth. It is expected that further studies of the changes that occur in levels of ascorbic acid and 'hormones' during the growth and dormancy of these yams will provide useful explanations.

ACKNOWLEDGEMENT

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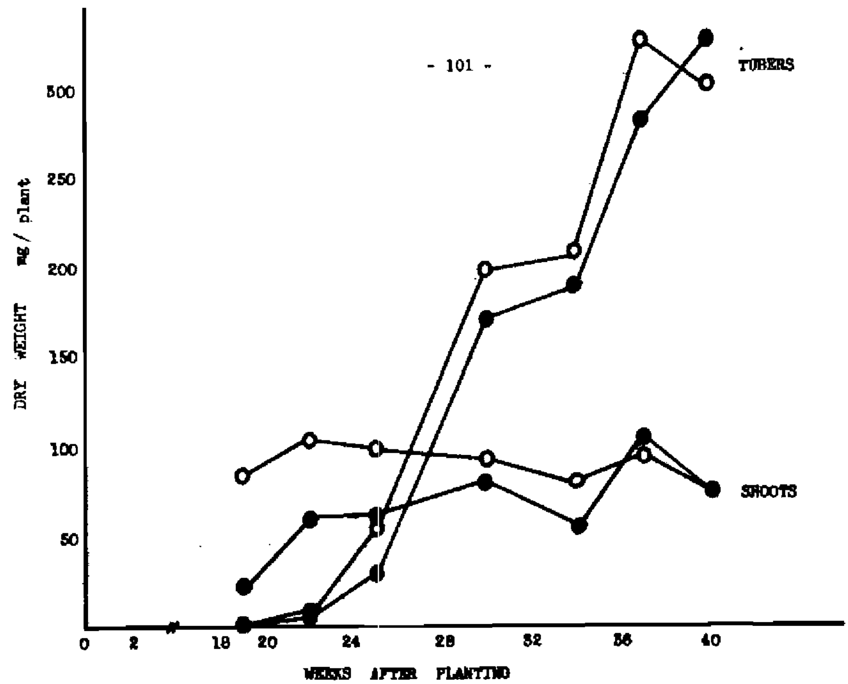

FIG. 1. Dry weight changes in *Dioscorea esculenta*. O large setts ● small setts

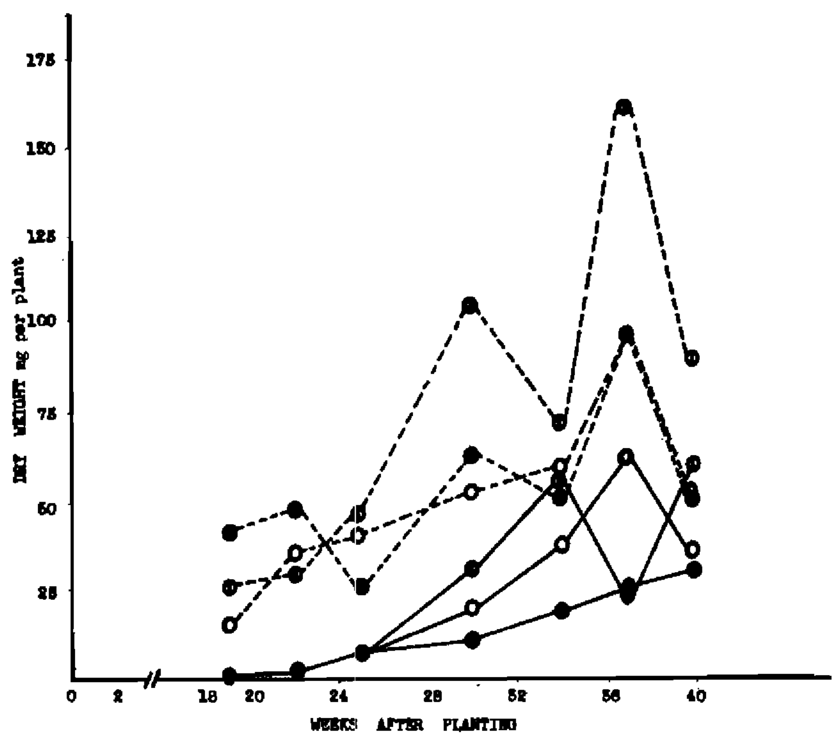

FIG. 2. Dry weight changes in *Dioscorea trifida*. O whole setts ● head setts ● tail setts ------- shoots ——— tubers

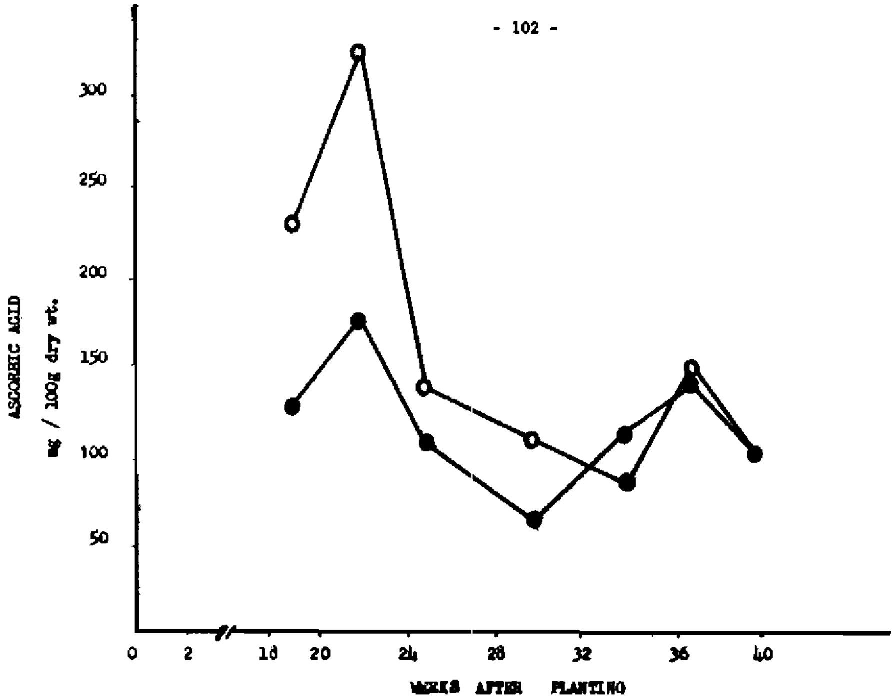

FIG. 3. Ascorbic acid levels (total) in tubers of *Dioscorea esculenta* ○ large set ● small set

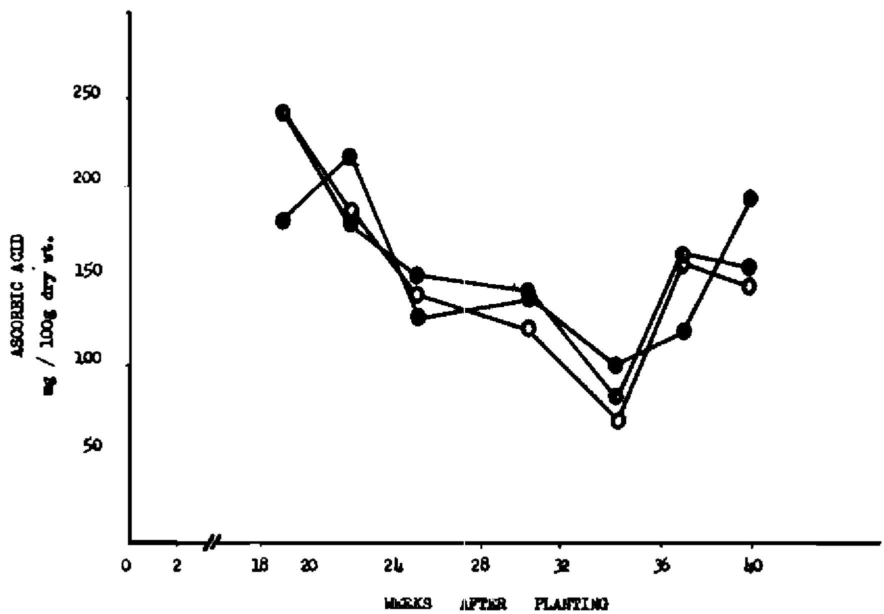

FIG. 4. Ascorbic acid levels (total) in tubers of *Dioscorea trifida* ○ whole setts ● head setts ◉ tail setts