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AGRONOMIC TECHNIQUES IN YAM (DIOSCOREA SPP.) PRODUCTION IN THE CARIBBEAN REGION

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INTRODUCTION

Yams are one of the more important food crops which can be found growing throughout the region. Yams are particularly valuable in the economies of Jamaica, Barbados, and St. Vincent. Jamaica is by far the largest grower, producing over 150,000 tons. Production in Barbados is estimated to be 15,000 - 18,000 tons (Gooding, 1970). Production in St. Vincent is estimated to be less than 500 tons.

In this paper various aspects to the agronomy will be examined and suggestions for improvement made.

VARIETIES

Varieties belonging to all the major edible species can be found throughout the region. The major edible species are Dioscorea rotundata, D. cayenensis, D. alata, D. trifida and D. esculenta. Each of these five species contain a large number of varieties which carry local names. Ferguson (1970) noted that the same variety may carry the same name in different areas and varieties of the same name may be of different species. This confusion has led to difficulties in the identification and classification of varieties. The work of Gooding (1960) has gone a long way in helping to sort out this problem. Martin (personal communication, 1972) has recently made a world collection of all the major edible species and is in the process of classifying them. Degras et al. (1973) have collected and described a large number of varieties in Guadeloupe.

Table I lists some of the more important varieties found in cultivation in the Commonwealth Caribbean region. The Chinese yam has been recognised as a variety with great potential (Ferguson and Haynes, 1970a) but it is still to be cultivated widely.

TABLE I SOME IMPORTANT VARIETIES OF YAMS AND THEIR DISTRIBUTION IN THE CARIBBEAN REGION

Variety	Species	Area(s) of importance
White /isbon (Farm Lisbon Crop Lisbon)	D. alata	Barbados, Trinidad St. Lucia, Leeward Is.
Coconut Lisbon	D. alata	Barbados
Oriental	D. alata	Barbados
Renta[1]	D. alata	Jamaica, Tobago
White	D. alata	Jamaica
Hard	D. alata	Jamaica
Sweet	D. alata	Jamaica
Water Yam	D. alata	St. Vincent
St. Vincent (Barbados)	D. alata	Jamaica
Statia	D. alata	Leeward Islands
Bottle-neck	D. alata	Leeward Islands
Negro	D. rotundata	Jamaica
Lucea	D. rotundata	Jamaica
Portugese	D. rotundata	St. Vincent
Eboe	D. rotundata	Tobago
Antoine	D. rotundata	Dominica
Yellow	D. cayenensis	Jamaica
Yellow Guineau[2] (Yam-a-tou-temps)	D. cayenensis	Grenada, Trinidad
Round Leaf Yellow	D. cayenensis	Jamaica
Cush Cush (Yampie [3])	D. trifida	Trinidad, Guyana, Jamaica
Chinese (Sweet, Fancy China)	D. esculenta	Of minor importance in Trinidad, Windward Islands and Jamaica.
Pana	D. esculenta	Tobago

1 May be different varieties in Jamaica and Tobago.

2 May be the same as Yellow yam in Jamaica.

3 Called Yampie in Jamaica.

PLANTING MATERIAL

Yams are propagated commercially by using either whole underground tubers or pieces of underground tubers. The propagules are called setts. The type of sett used and its method of production vary with species.

(i) D. esculenta

For D. esculenta (e.g. Chinese yam), small whole tubers are normally used. These tubers may vary in size from 25 - 100 gm. They are usually the small unmarketable tubers of the previous crop.

(ii) D. trifida

For D. trifida (e.g. Cush-Cush or Yampie), small tubers or pieces of tubers of about 50 - 100 gms are used. Ferguson (1973) noted that tubers decompose rapidly after cutting and suggested that unless suitable methods could be found to prevent this rapid decomposition the use of cut pieces of D. trifida should be avoided.

(iii) D. alata

For D. alata most farmers in the region use setts ranging in weight from 100 gms. to 300 gms. In Barbados, St. Kitts and Trinidad the sett size for the White Lisbon variety is normally in the range of 115 - 175 gms. However in Jamaica setts of up to 3 Kg are often used for some varieties.

Setts of D. alata may be pieces of large tubers or whole tubers of the appropriate weight. Pieces of large tuber (called "bits" in Jamaica) may be taken from any part of the tuber. Those from the head or top section (proximal to the vine) are called heads, those from the middle section, middles and those from the bottom or tail section, tails. Heads are generally preferred to middle and tail setts. Ferguson (1973) found that heads of White Lisbon yam are very efficient and setts as small as 57 gm will give good yields. Small whole tuber of D. alata are often preferred by farmers. However, experim-experimental evidence indicates that whole tubers of equivalent size of heads, middles or tails are inferior to these setts (Gooding and Hoad, 1967; Ferguson, 1973). One possible disadvantage in using small whole tubers is the probability of selecting for genetically low yielding clones (assuming some genetic variation within a given popluation) and diseased material. For best results it is recommended that setts should always be taken from large healthy tubers of varieties of D. alata.

Aerial tubers of yams are not normally used as setts in commercial production. Ferguson (1973) has shown that yields of over 40 tons per ha can be obtained using aerial tubers as setts in White Lisbon yam. Aerial tubers are however secondary carbohydrate sinks and assimilates are only diverted to these when the primary sinks (the underground tubers) have achieved their maximum bulking rate. As a result only a limited amount of aerial tubers are normally produced and the majority are very small (less than 30 gms). The writer is of the opinion that it is physiologically possible to develop a system which will allow for greater aerial tuber production in some D. alata varieties. This is an obvious area for future research activities.

(iv) D. rotundata

The system of obtaining setts for propagat on of D. rotundata differs markedly from those described for D. alata, D. trifida and D. esculenta. Varieties of D. rotundata are normally propagated by setts which are called yam heads locally. A yam head is the secondary underground tuber produced by the yam plant and harvested 3 - 5 months after the primary tuber(s) is harvested. In this system, at 6 - 8 months after planting the hill (most of the D. rotundata yams are grown in hills) is carefully dug on one side so as to avoid destroying many roots. The primary tuber(s) is removed by slitting just below the primary nodal complex (cf. Ferguson, 1973). The hill is then remade and left intact for another 3 - 5 months. During this time the plant produces another tuber(s) which is harvested as the yam head. Great variation exists in shape and size of yam heads so produced. They may vary in weight from 0.5 Kg to 5 Kg. These are often planted without any selection. Farmers in Jamaica seem to prefer yam heads in the range of 0.75 - 2 Kg for Negro and Lucea Yam.

The primary tubers of D. rotundata may also be left in the soil undisturbed for 9 - 12 months and then harvested. When this is practiced the head section is cut off (junked) and used as a sett. The size of these setts are usually in the range of 0.5 - 3 Kg.

It is the writer's opinion that under good growing conditions such large setts are not necessary. It is his view that the size of yam heads in Jamaica has increased over the years through an unconscious attempt by farmers to combat the plant parasitic nematode problem (to be discussed in more detail later in this paper). This is an area which requires immediate investigation not only to increase yields but to reduce the financial outlay for the large quantity of setts required.

In some varieties of D. rotundata (e.g.Lucea) it is possible to use pieces of large tubers other than from the head region as setts. However they do not sprout as readily as head setts and more failures are likely to occur after planting. They are only recommended for general use when there is a shortage of head setts.

(v) D. cavenensis

For D. cavenensis, setts are usually collected by taking the head section of mature tubers (i.e. head setts as a result of junking). As for D. rotundata these are large (1-4 Kg) and sometimes consist of 50% or more of the primary tuber. Some varieties are also cut (slit) early and yam heads allowed to develop. Again these are large (1-4 Kg). Indications are that the nematode problem may be greater in this species.

TIME OF PLANTING

There are two main periods in which yams are planted in the Caribbean region - April to June and November to March. Varieties belonging to D. alata, D. esculenta normally planted in ther period April to June and varieties belonging to D. rotundata planted in ther period November to March. Many varieties of D. cavenensis (e.g. Yellow yam, Yam-a-tou-temps) can be planted all year round. They are however mostly planted in the period April - June.

The tubers of all edible yams have a dormant period which may vary from 3 weeks (Yellow yam) to 3 months (White Lisbon). As a general rule all yam tubers should be planted just before they begin sprouting towards the end of their dormant period.

Yams are often planted late in the Caribbean. Late planting has been shown to result in low yields (Gooding & Hoad, 1967; Enyi, 1970). In later planting, setts are often taken from sprouted tubers. Substantial amounts of carbohydrates, minerals and other growth factors would have moved into the growing sprout from the tuber. Setts taken from such a tuber, in which the sprout is usually broken off, are obviously weakened setts and can only produce a poor plant which will most likely give a poor yield.

In Trinidad and Barbados where the White Lisbon yam is grown it is essential that all yams be planted before the end of May which represent the end of the dormant period in this variety.

It should be noted that good agronomic practices are unlikely to compensate for poor setts planted late.

Early planting of D. alata by the breaking if dormancy in tubers with 2 - chloro-ethanol is possible (Campbell et al, 1962; Ferguson, 1969). The commercial feasibility of this approach is however still to be demonstrated.

LAND PREPARATION

There are two distinct systems of land preparation for yams in the Caribbean - the hill (mound) system and the ridge system.

(i) The hill system

Hills are used extensively throughout the region. Barbados is one of the few territories where they are hardly used.

In this system a hole which may vary in width and depth from 0.5 - 1m is dug. the hole is then refilled with loose soil and trash or trash alone and then mounded up with soil. The hills may vary in height from 20 cm to 90 cm. Two to six yam setts are planted around the top of the hill depending of variety.

In Jamaica, where large quantities of yams are grown and most of these on hills, the preparation of the yam hill is a key operation in their system of production. Digging yam hills as it is called is considered to be one of the more expensive and laborious operations.

On heavy soils the holes are often dug and the soil so removed left to dessicate for a few weeks before the hole is refilled. Dessication of the soil seems to offer two advantages:

(a) The structure of the soil is improved by weathering in the open and

(b) some plant parasite nematodes are likely to be killed by the drying of the of the soil.

The soil between hills is often forked and intercropped.

Two of the major problems encountered in using hills are the limitations of mechanisation and the aggravation of soil erosion on sloping land. Hills are not easily made mechanically and as a result their formation will most certainly continue to be manual. The high labour input will greatly restrict the acreage any one farmer can handle. The use of hills on steep hillsides is common throughout the Caribbean. Soil erosion is greatly increased when hills are formed on such slopes. The soil erosion problems in the yam growing areas of Christiana and Lucea in Jamaica are well known. The introduction or increased use of soil conservation measures and/or the moving of yams (and other root crops) off the very steep hillsides are topics warranting immediate attention.

(ii) The ridge system

Ridging has been in use in Barbados for many years. In that country yams are traditionally planted on wide ridges (1.68 m) which are prepared for sugar cane cultivation. It has been shown that higher yields can be obtained with ridges at 0.48 m apart (Gooding and Hoad, 1967). However, only very few Barbadian farmers use narrow ridges.

Ridges are also used to a limited extent in St. Kitts, Antigua, Puerto Rico and Jamaica.

Ridging is an operation that is very easy to mechanise. It is also substantially cheaper than forming hills. Forming ridges on the contour on hillsides is one way of reducing the soil erosion problem.

Before ridging it is recommended that the land should be ploughed, harrowed and rotavated.

PLANTING

Planting of yams is normally a manual operation in all Caribbean territories whether ridges or hills are used. Setts are usually planted to a depth of 5 - 8 cm. In Jamaica 2 or 4 setts are planted per hill. The total weight per hill is usually in the region of 3 - 5 kg.

Mechanical planting of yams has been tried in both Trinidad and Barbados. In Trinidad a modified potato planter is used with some success for White Lisbon yams. However, the spacing of that planter is fixed at 68 cm which is perhaps too narrow for yams. In Barbados, Chandler (1973) has built a planter specially for yams and has had good success planting White Lisbon yams on ridges 1.68 m apart.

SPACING

Spacing between hills range from 1.5m x 1.5m to 3.0m x 3.0m. This gives a range of 1,110 to 4,440 hills per hectare and plant population will range from 3,330 to 13,320 plants per hectare when three setts are planted per hill.

In Barbados yams are usually planted on ridges 1.68m apart and spaced 0.75

to 1.50m apart in the row. Closer ridge spacing of 0.84m and setts spaced at 0.75 in the row has been shown to give higher yields (Gooding and Hoad, 1967). Most farmers however still persist in using wide ridges because the yam as grown in Barbados is a secondary crop grown in a system intended for sugar cane.

Ferguson (1973) showed that in White Lisbon yam spacing is closely interrelated with sett size in its effect on yield. The total amount of setts planted per acre is the seed rate and it can be varied by changing either sett size or pacing. As asymptotic yield response curve is got when seed rate is increased. Head setts are more efficient and the optimum seed rate for head setts is lower than the optimum seed rate for middles.

STAKING

Yams are normally staked in the wetter territories. They are not staked in Barbados, Antigua and St. Kitts. In Jamaica and St. Vincent, two wet territories, there are some varieties which are grown without stakes. For example the White Yam (F. alata) in Jamaica and Water Yam (D. alata) in St. Vincent are not usually staked. In both these countries some highly valued D. rotundata varieties are always staked (e.g. Negro and Lucea in Jamaica and Portuguese in St. Vincent).

Staking has been shown to increase the yield of D. alata in Trinidad (Chapman, 1965) and D. rotundata in Puerto Rico (Caro-Costas & Servando, 1968). Increases in yield by staking are not always economic and the recommendation for a particular area must always take into consideration the variety, the cost of staking and the local climatic conditions.

The traditional system of staking involves the use of individual poles. These may be bamboo or some readily available wood. In the hill system one pole is normally used per hill and where ridges are used on pole may serve 2 - 4 plants. Poles may vary in height from 1m to over 6m. In Jamaica short poles (1-2m) are used for Sweet yam whereas poles for Negro, Lucea and Yellow yams are often over 3m.

Staking by the use of individual poles is another expensive and laborious operation. In Trinidad, Haynes (1967) described a trellis system of staking developed at the University of the West Indies. It involves the use of slung wires which are supported by teak poles and bamboos. This system has been modified by Payne (1971) and introduced to Jamaica for use on D. rotundata and D. cavenensis. Not many farmers have adopted this system and some likely reasons are:

(1) Lack of ready cash or credit for the high initial capital required.

(2) The small acreage grown by the farmer may not justify the use of this system.

(3) It is not suited to the hillsides where most of the yam farmers are located.

(4) It does not stand up to high winds.

(5) Some farmers (in Jamaica especially) already have expensive hard wood stakes.

WEED CONTROL

Practically all weed controls in yams in the Caribbean region is done by hand. Generally at least two hand weedings are required during the life of the crop. In Barbados yams are planted in fields which are more or less weed-free as a result of being in sugar-cane for the previous 4-5 years. Under such circumstances only one hand weeding may be necessary. In Trinidad on the other hand, weedy fields are the rule and crops are sometimes weeded as many as seven times (Newhouse & Wilson, 1969). In Jamaica crops are usually given 2 or 3 weedings.

The herbicides atrazine (Gesaprin 80) at 2+Kg/ha is recommended for weed control in yams (Kassasian & Seeyave, 1968). It is used regularly by a few farmers in Barbados. In other territories it is rarely used. Christie (1973) recommended the use of either ametryne (Gesapax - Combi 80 WP) at 4.5 - 6.7 Kg/ha or atrazine (Gesaprim 500 FW) plus ametryne (Gesapax 500 FW) at 1.2 - 1.9 liters/ha each for weed control in Yellow yams.

MULCHING

Mulching is practiced to any great extent only in Jamaica. Banana leaves green trash may be used. Mulching helps by reducing weed growth and conserving moisture. It may also have some benefit in the moderation of soil temperatures and possibly on the reduction of plant parasitic nematode population. This is an area which requires some investigation.

FERTILIZER USE

The status of fertilizer use in yams in the Caribbean is somewhat confusing. In Trinidad, although fertilizers are recommended for use in yams, they are hardly used. In the Windward Islands fertilizers intended for use on bananas are often used indiscrimately on yams. In Barbados some farmers use sulphate of ammonia and muriate of potash applying about 190 Kg/ha of each. In the Leeward Islands fertilizers are often not used. In Jamaica some farmers use 0.25 Kg to 0.50 Kg of 6:18:27 or 6:6:18 per hill.

Ferguson & Haynes (1970b) noted that different varieties respond differently to the same fertilizer application. It is therefore important to know the response potential of a particular variety before firm fertilizer recommendations could be made. Recommendations will of course have to vary with soil type and local climatic conditions.

Chapman (1965) and Ferguson & Haynes (1970b) found that the yield of the White Lisbon yam increases with increasing nitrogen application. Chapman (1965) recommended nitrogen application at 3 months after planting but Ferguson and Haynes (1970b) presented evidence which indicates that the plant may be able to utilise added nitrogen from about eight weeks.

Payne (1971) recommended the use of 630 Kg/ha of the NPK fertilizer, 12:24:12, for negro yam on the red and brown bauxite soils of Jamaica.

PRUNING

The pruning of side shoots of yams has only been observed on Negro and Yellow yams in Jamaica. The side shoots at the base of the main stem and weak stems are removed. In relation to the labour input involved this operation seems to be of questionable value. Farmers claim benefits from the increased amount of light reaching the hill and the increased ability of the main vines to climb the stakes. This is another area for research.

PLANT PROTECTION

Field observations indicate that nematode damage (locally called tuber "burn") is rampant in many areas of Jamaica. Yellow yam and Yampie appear to be among the more susceptible varieties. Nematodes in addition to reducing yield may reduce the life and lower the quality of the tubers in storage and greatly reduce the quality of the setts.

Although there is no published data (at least to the writer's knowledge) on the magnitude of the nematode problem in yams it is the writer's firm opinion that this could be one of the most important factors affecting yam production in Jamaica. There is immediate need for

(1) a survey of all yam growing areas for plant parasitic nematodes to establish genus and species of nematodes, involved, varietal susceptibility, variations according to soil types and other climatic conditions, etc.

(2) the development on a field scale of a system of producing nematode-free planting material.

(3) the control of nematodes in the field.

Fungal leaf diseases pose real problems in Jamaica, Barbados, St. Vincent and Trinidad. The most serious disease is the black spot on leaves. This disease if of a complex nature and two of the casual organisms have been identified to be Phyllosticta spp. and Colletotrichum spp. Control is achieved in Trinidad with regular sprays of Miltox and Dithane M45. Benlate is recommended for use in Barbados. Control measures are however not widespread among farmers.

Another serious disease of importance in the region and which has at times assumed edpidemic proportions in Barbados is the internal brown spot of tubers. A research project is now in progress on this disease, which is believed to be caused by a virus, at the University of the West Indies. It is discussed in more detail in a paper elsewhere in these proceedings.

CROPPING SYSTEMS

Intercropping yams with wide range of food crops is the normal practice in most Caribbean territories. Crops such as corn, pigeon (gungo) peas, red peas, irish potatoes, tannias, sweet potatoes, calaloo (Amaranthus spp.) are often used.

In Jamaica yams are often rotated with a fallow period. Yams are usually grown for 3 - 5 years and followed by a fallow period 1 - 2 years.

Little attention has been given by agronomists or agricultural economists to these traditional cropping systems. Some of them merit some study as they may help us in understanding the versatility of many of our small farming systems.

In Barbados where yams are grown on a more extensive basis they are rotated with sugar-cane. The sugar-cane is grown for 4 or 5 years and theland is then "thrown-out" of sugar-cane. It is normally cultivated as for sugar-cane and planted with yams on ridges 1.68m apart at about May/June. Sugar-cane is then planted in the furrows in about October/November. The yams are harvested in January/February. The land preparation for the yams is normally charged to the cane crop and the yam is considered to be the secondary crop. The merits of this system are that farmers get two crops for the cost of a single land preparation and a crop of canes is established well before the onset of the dry season when it would otherwise be difficult. The major disadvantage of this system is that yams cannot be harvested mechanically because of the presence of young canes in the furrows. However, until such times that an economical package for mechanical harvesting can be offered to the farmers they may be justified in intercropping with canes.

HARVESTING

Harvesting of yams is practically all accomplished with the use of hand implements. These implements may be garden forks, machetes, hoes or simply digging sticks. The tool used will depend on the soil type, territory and method of production. Hoes are used on the light soils of St. Kitts to harvest yams on ridges. In Jamaica a digging stick is used on lighter soils and a machete or garden fork on the heavier soils. In Barbados, Trinidad and the Windward Islands the garden fork is the tool most often used.

Harvesting of yams is considered to be the most laborious operation i yam growing in Barbados and Trinidad. Mechanical harvesting has been attempted with some success in both these countries. Campbell (1967) has developed a side-lifter which has given very promising results with White Lisbon and Chinese yam in Trinidad and with White Lisbon yam in Barbados. Jeffers and Harvey (1973) reported good results with a harvesting aid in Barbados.

We are still a long way from mechanised harvesting in D. rotundata and D. cayenensis.

Research into mechanical harvesting of yams is an area for continued and increased research input.

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