A CULTIVAR TRIAL WITH YAMS *DIOSCOREA ALATA* L. IN THE BRITISH SOLOMON ISLANDS

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ABSTRACT

In a trial with yam cultivars, the yield of tubers ranged from 15.89 *to* 36.85 *t/ha, after a growing period of* 199 *days. The cultivars with pigmented tubers out-yielded the non-pigmented ones. The mean weight of planting material used was* 2.37 *t/ha and the mean sett weight* 88 *g.*

Storage trials showed that non-pigmented tubers stored better than pigmented ones, and that weight losses were mainly due to respiration. After 172 *days storage, non-pigmented tubers showed a weight loss of* 11.6 *per cent, whilst pigmented ones lost* 24.5 *per cent.* D. alata *tubers lost* 6.3 *per cent of weight due to moisture losses and* 36.2 *per cent due to respiration after a storage period of* 213 *days.* D. esculenta *tubers lost* 22.7 *per cent of weight after* 123 *days storage,* 4.1 *per cent being due to moisture loss and* 18.6 *to respiration. The pigmented tubers of* D. alata *sprouted earlier and more profusely than the non-pigmented tubers.*

INTRODUCTION

YAMS *Dioscorea* spp. together with sweet potatoes *Ipomoea batatas* (L.) Lam. and taro *Colocasia esculenta* (L.) Schott are major food crops in the Solomon Islands. In general, where yam culture is important the taro crop is of less significance; Barrau (1965) has discussed this and emphasized the differing ecological requirements of the two crops.

Sweet potatoes however tend to be grown by both the taro and yam planting communities. Whilst taro production tends to be on the decline partly due to diseases, yam production is sustained in those areas which have a tradition of yam growing.

The two most important yam species in the Solomons are *D. alata* L. and *D. esculenta* (Lour.) Burk. Three others, *D. bulbifera* L., *D. nummularia* Lam. and *D. pentaphylla* L., are sometimes planted, but are also found in the natural state and are often foraged (Barrau 1958).

The climate of the Solomons is wet tropical with a mean annual rainfall which is fairly evenly distributed exceeding 3,000 mm for most coastal areas, with a possible 8,000 mm or more for the mountain ranges located towards the centres of the main islands. Mean monthly rainfall exceeds 125 mm in most areas. Mean maximum temperatures seldom exceed 31° C and mean minimum temperatures seldom fall below 21° C. Average relative humidity approximates to 80 per cent throughout the year.

Many of the coastal soils are formed over raised coral reefs, and have been found to be low in available potassium content (Ballantyne 1961).

Work commenced at Dala Experimental Station on Malaita during 1967 on local food crops, and this paper describes cultivar and storage trials with yams.

MATERIALS AND METHODS

Cultivar Trial

A trial consisting of eight cultivars of *D. alata* from Malaita was planted on 11th September, 1970. The plot size excluding guard rows was 0.0018 ha., i.e., 49 plants spaced at 0.6 x 0.6 m; the experimental design was a randomized block with three replicates.

Land was cleared by cutting and burning of bush which was about 4.5 m high. The tubers were cut into setts nine days before planting, each sett being marked, as is local practice, to indicate the end taken from nearest the tuber head. The mean weight of each sett was 88 g, and the planting rates are shown in *Table* 1.

At planting, the ground was dug and loosened to a depth of about 35 cm, the diameter of the cultivated area per stand being approximately 35 cm at the soil surface. One sett was planted per stand, at a depth of 3 to

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Table 1.—Yield and planting data of yams in cultivar trial

Cultivars of *D. alata*	Yield of tubers (t/ha)	Mean weight of tubers (Kg)	Mean number of tubers per plant	Planting Material	
				(g/sett)	(t/ha)
Lawanihara	36.85a	0.95a	1.7	104.3	2.81
Hutohuto	25.15	0.82b	1.2	78.5	2.11
Inemauri	21.49	0.59bc	1.4	78.5	2.11
Toma	20.96	0.45cd	1.8	112.8	3.04
Talabuli	20.61	0.59bc	1.4	83.1	2.23
Asikare	19.50	0.50cd	1.4	95.3	2.56
Rokea	17.19	0.50cd	1.3	71.7	1.93
Kai	15.89	0.27d	2.3	80.2	2.16
Mean	22.21	0.58	1.6	88.1	2.37
Standard error	±3.31	±0.08	±0.26	±5.11	±0.14
Coefficient of variation	25.9%	24.3%	27.9%	16.6%	16.6%

Mean separation by Duncan's Multiple Range Test.

Means followed by letter 'a' are significantly different from those means not having 'a', etc. (P = 0.05).

4 cm below the surface. Setts were planted at an angle with the head end facing upwards. No hilling was done, the cultivated area being only slightly higher than the undisturbed ground. This is the standard planting procedure for the "Kwara'ae" district of Malaita. The spacing of 0.6 x 0.6 m gave 26,888 setts per hectare.

Stakes of about 2.4 m height were provided at 18 days after planting, one stake for each plant. No fertilizer was applied to the crop. Harvesting took place on 29th March, 1971 at 199 days after planting and the tubers were dug out with digging sticks.

Storage Trial 1

The tubers from the above trial were used in a storage trial, together with tubers from two other *D. alata* cultivars. The tubers were weighed four days after harvest, and then placed on wooden shelves in a well-ventilated rat-proof store room. Only sound undamaged tubers were selected. The design was four randomized blocks, and each unit consisted of 5.0 kg of tubers.

At monthly intervals the tubers were weighed, and the percentage weight losses calculated. A sprouting index was also assessed at monthly intervals, by scoring for the amount and length of sprouts on the following scale: 0 = no sprouting; 1 = slight sprouting; 2 = moderate; 3 = excessive.

The trial started on 2nd April, 1972, and was terminated on 22nd September, 1972, after 172 days' storage.

Storage Trials 2 *and* 3

These trials consisted of one non-pigmented cultivar of *D. alata* "Inemauri", and one of *D. esculenta* "Fananiu". The aim of the trials was to determine the percentage weight losses during storage, and to ascertain if these were due to moisture changes, or to other losses, e.g., respiration.

Storage commenced at seven and two days respectively after harvest for the *D. alata* and *D. esculenta* cultivars. The tubers were stored in the case of *D. alata* for 213 days, and for a period of 123 days for *D. esculenta.*

Moisture determinations were made at monthly intervals by selecting tubers at random, slicing them and oven drying for 24 hours at 100° C. The sprouting indices were assessed as in the first trial. The designs were randomized blocks with five replicates for *D. alata* and four for *D. esculenta.*

RESULTS

Cultivar Trial

Tuber Yields

The yields of tubers in t/ha are given in *Table* 1, from which it can be seen that cv. "Lawanihara" had a significantly higher yield

than the seven other cultivars, all of which produced yields which were not significantly different. There were significant differences between the tuber mean weights of cultivars. The yield of tubers was not correlated with the mean weight of planting material used per hectare, and the mean recovery ratio of weight planted to tuber weight harvested for all cultivars was 1:9.4. The two highest yielding cultivars had pigmented tubers, while the tubers of the other cultivars were non-pigmented.

Pests and Diseases

The mean weight of tubers damaged by the beetle *Papuana* spp. (Stapley, personal communication 1971) in the trial was 0.24 t/ha or 1.0 per cent by weight. The damage to tubers resembled that described by Coursey (1967) in West Africa, as caused by *Heteroligus* spp. The percentage by weight of tubers damaged was very low, and the damage to individual tubers slight.

Only the cv. "Asikare" was infected with an unidentified tuber rot. The weight of tubers of this cultivar infected was 0.55 t/ha or 2.8 per cent by weight.

At about 100 days after planting, symptoms resembling virus infection were observed on all cultivars except for the two with pigmented tubers (cvs. "Lawanihara" and "Hutohuto"). The symptoms were that the young leaves towards the tips of shoots became curled, cupped and leathery, with brown margins and tips.

Leaf spots were observed on the foliage of all cultivars at about four months after planting, but damage appeared to be very slight in most cases. From infected leaf tissue forwarded from Dala, the Commonwealth Mycological Institute isolated the following organisms: *Botryodiplodia theobromae* Pat.; *Collecotrichum capsici* (Syd.) Butler and Bisby; *Colletotrichum* state of *Glomerella cingulata* (Stonem.) Spauld and Schrenk; and *Phomopsis dioscoreae* Sacc. Johnston (1960) found *Glomerella cingulata* and *Biharia* sp. associated with leaf spots of *D. alata* on Malaita.

Climatic Data

During the growing period of the crop, the mean daily rainfall was 14.4 mm, 2,860 mm being recorded for the whole period. The mean daily sunshine was 5.4 hrs, the mean maximum and minimum temperatures 30.3° C and 22.7° C, and the mean relative humidity 79.7 per cent, recorded at 0900 hrs.

Storage Trial 1

The mean percentage weight losses of the tubers together with their sprouting indices are given in *Table* 2. The values refer to the means of the non-pigmented cultivars (8), and of the pigmented cultivars (2). The red-fleshed tubers had a much poorer storage quality than the white-fleshed tubers, and they also sprouted more.

After 172 days storage the non-pigmented tubers had a mean percentage loss in weight of 11.6, whilst that for the pigmented tubers was 24.5. The mean values for the sprouting indices were 42.7 and 100.0 for the non-pigmented and pigmented tubers respectively after 154 days storage. The sprouts were removed after weighing at 154 days storage, but any sprouts which grew after this were included in the final tuber weights recorded.

Storage Trials 2 *and* 3

The moisture contents and percentage losses due to moisture changes and respiration processes are shown in *Tables* 3 and 4 for the *D. alata* and *D. esculenta* tubers respectively.

After 213 days storage the moisture content of the *D. alata* tubers had fallen by 6.3 per cent to 69.1 per cent. The total percentage loss in weight for the period was 42.5 per cent, and respiration processes can thus be assumed to account for 36.2 per cent loss. The sprouts were removed after weighing at 182 and 213 days of storage, and before oven-drying for moisture determinations. The sprouting index at 182 days was assessed as 66.7 per cent.

The *D. esculenta* tubers lost 4.1 per cent of weight due to moisture losses after a storage period of 123 days, the other weight losses assumed to be due to respiration were 18.6 per cent, making a total weight loss of 22.7 per cent. Sprouting commenced after 32 days storage, and the sprouting index was 100 per cent by 100 days.

Mealy bugs *Planococcus dioscoreae* Williams were found on both the *D.* alata and *D. esculenta* tubers in all three storage trials, and tended to be concentrated towards the head end of the tubers from which most sprouts emerged. They became apparent on the *D. alata* tubers after about 150 days of storage,

Table 2.—Mean percentage weight losses and sprouting indices of yam tubers in storage trial

	Storage Period (days)					
	31	62	94	123	154	172
Percentage weight losses						
Non-pigmented tubers (eight cvs)	3.1	4.9	6.0	8.7	10.7	11.6
Pigmented tubers (two cvs)	6.2	7.8	9.6	14.6	21.0	24.5
Sprouting indices						
Non-pigmented tubers	0	0	0	14.6	42.7	
Pigmented tubers	0	8.3	83.3	100.0	100.0	

$$\text{Sprouting index} = \frac{\text{Score} \times 100}{\text{Total possible score}}$$

Table 3.—Percentage weight losses of *D. alata* tubers after storage, showing moisture contents and changes due to moisture and respiration

Days of storage	0	28	59	91	120	151	182	213	Total
Moisture contents (per cent)	75.42	73.92	73.96	75.14	74.22	71.66	71.28	69.14	
Standard error±	0.63	0.24	0.84	2.10	1.38	0.80	0.92	0.84	
Moisture weight changes (per cent)	—	—1.50	+0.04	+1.18	—0.92	—2.56	—0.38	—2.14	—6.28
Other weight losses (per cent)	—	1.04	0.78	4.04	0.66	7.08	17.18	5.44	36.22
Total weight losses (per cent)	—	2.54	3.28	6.14	7.72	17.36	34.92	42.50	
Sprouting indices (per cent)	0	0	0	0	0	16.6	66.7		

Table 4.—Percentage weight losses of *D. esculenta* tubers after storage, showing moisture contents and changes due to moisture and respiration

Days of storage	0	32	61	92	123	Total
Moisture contents (per cent)	72.58	70.73	74.08	71.03	68.53	
Standard error±	1.02	1.39	1.27	1.56	1.73	
Moisture weight changes (per cent)	—	—1.85	+3.35	—3.05	—2.50	—4.05
Other weight losses (per cent)	—	5.25	7.00	3.93	2.40	18.58
Total weight losses (per cent)	—	7.10	10.75	17.73	22.63	
Sprouting indices (per cent)	0	8.3	50.0	100.0	100.0	

and in the case of *D. esculenta* after 100 days. This species of *Planococcus* described by Williams (1960), was found to cause severe damage to tubers of yams in storage in Papua New Guinea.

No rots developed on any of the tubers in the three trials over the entire storage period.

The mean temperatures and relative humidity recorded at the meteorological station at Dala during all three storage periods were similar. The mean maximum temperature was 30.4° C, mean minimum 22.2° C, and mean relative humidity recorded at 0900 hrs was 81.7 per cent. No readings were taken in the storage room.

DISCUSSION

In the "Kwara'ae" district of Malaita, the method of planting *D. alata* is different from that used for *D. esculenta*. In the latter case small seed tubers of approximately 0.26 kg weight are placed at the bottom of the planting hole, with the head end facing downwards. Lea (1966) describes how, in Papua New Guinea, *D. alata* seed tubers are planted near the top of the planting mound. In Trinidad the normal planting procedure is for setts of approximately 113 g to be planted on ridges at a spacing of 1.2 x 0.3 m (Campbell and Gooding 1962). Spacing of setts is normally wider than that used at Dala (Waitt 1963).

Staking is important in its effect on yield (Waitt 1963), and has been shown by Chapman (1965) to increase tuber yields because of the production of a higher leaf area duration, and a more efficient foliage display.

The yields of tubers ranging from 15.89 to 36.85 with a mean of 22.21 t/ha for the eight cultivars are comparable with those quoted for the West Indies, whilst the mean weight of tubers 0.58 kg is smaller than normal (Coursey 1967). This was possibly because of the close spacing used. The growing period in the trial of approximately 200 days is about a month less than that for Trinidad (Chapman 1965, Haynes 1967). The mean number of tubers per plant was similar to the norm for *D. alata* cultivars, and there was no correlation between the yield of tubers, and the mean number of tubers per plant.

Pests and diseases appeared to be of little importance in the trial. The leaf spots probably had little effect if any on yields, as they were not significant until towards the end of the crop cycle.

Gooding (1960) found that *D. alata* cultivars had a percentage weight loss after a storage period of 116 days of 14.1 per cent; 8.7 per cent for the white fleshed cultivars and 23.1 per cent for the pigmented ones. The one *D. esculenta* cultivar in the trial had a weight loss of 24.6 per cent. At Dala the weight losses for the non-pigmented tubers and for *D. esculenta* after 123 days storage were similar to the values given by Gooding (1960).

Campbell *et al.* (1962) reported weight losses of 10-14 per cent in *D. alata* tubers after four months storage, and 20-24 per cent at six months. By seven months, weight losses had risen to approximately 47 per cent. Final weight losses were similar at Dala (*Table* 3) to those determined by Campbell *et al.* (1962) for their untreated tubers. Sprouting was not apparent until 150 days (*Table* 3), whereas in trials by Campbell *et al.*, sprouting commenced after about 100 days' storage. The removal of sprouts at 182 days probably slowed down the losses due to respiration from 17.18 to 5.44 per cent (*Table* 3).

The slight increases of moisture content in *Tables* 3 and 4, at 59 and 91 days for *D. alata*, and at 61 days for *D. esculenta* tubers suggest uptake of water from the atmosphere. Coursey (1961) working with *D. rotundata* considered that respiration accounts for considerable losses in weight of stored yams as only slight changes in the moisture content usually take place during storage. Weight losses other than those due to moisture losses were therefore assumed to be due to respiration in this study, as no rots developed in the stored tubers.

The pigmented cultivars in the trial were the highest yielders, but also the poorest keepers, and they sprouted earlier than the non-pigmented cultivars.

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REFERENCES

BALLANTYNE, A. O. (1961). *A Report on the soil survey of the Guadalcanal Plain and other areas of the British Solomon Islands Protectorate. April,* 1959-*April,* 1961. Govt. Printer, Honiara (Mimeographed).

BARRAU, J. (1958). *Subsistence agriculture in Melanesia.* B. Bishop Mus., Honolulu, Bulletin No. 219.

BARRAU, J. (1965). L'humide et le sec. *J. Polynesian Soc.* 74 (3) 329-346.

CAMPBELL, J. S., CHUKWUEKE, V. O., TERIBA, F. A. and HO-A-SHU, H. V. S. (1962). Some physiological experiments with the White Lisbon Yam (*Dioscorea alata* L.) in Trinidad III. The effect of chemicals on storage. *Emp. J. exp. Agric.* 30, 335-344.

CAMPBELL, J. S. AND GOODING, H. J. (1962). Recent developments in the production of food crops in Trinidad. *Trop. Agric.* (*Trinidad*) 39. 261-270.

CHAPMAN, T. (1965). Some investigations into factors limiting yields of the White Lisbon yam (*Dioscorea alata* L.) under Trinidad conditions. *Trop. Agric.* (*Trinidad*) 42, 145-151.

COURSEY, D. G. (1961). The magnitude and origins of storage losses in Nigerian yams, *J. Sci. Food Agric.* 12 (8), 574-580.

COURSEY, D. G. (1967). *Yams.* London, Longmans, Green.

GOODING, H. J. (1960). West Indian *"Dioscorea alata"* cultivars. *Trop. Agric.* (*Trinidad*) 37, 11-30.

HAYNES, P. H. (1967). The development of a commercial system of yam production in Trinidad, *Trop. Agric.* (*Trinidad*) 44, 215-221.

JOHNSTON, A. (1960). *A preliminary plant disease survey in the British Solomon Islands Protectorate.* F.A.O. Rome, mimeograph.

LEA, D. A. M. (1960). Yam growing in the Maprik area. *Papua New Guinea agric. J.,* 18 (1), 5-15.

WAITT, A. W. (1963). Yams, *Dioscorea* species. *Field Crop Abstr.* 16, 145-157.

WILLIAMS, D. J. (1960). A new Species of *Planococcus* Ferris (Coccoidea:Homoptera) on yams in New Guinea. *Papua New Guinea agric. J.,* 13 (1), 39-40.

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