AN INVESTIGATION OF CULTURAL FACTORS AFFECTING THE YIELD OF YAMS

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SUMMARY

AN experiment designed to test the effects of the number of setts per hill, spacing of hills, depth of planting-hole and staking on the yield of two varieties of yams, was set down at Peradeniya in *yala*, 1943. Significantly higher yields were obtained with two four-ounce setts per hill than with one.

A hill spacing of 3 ft. by 1½ft. was significantly superior to one of 3 ft. by 3 ft.

Staked plants significantly outyielded unstaked plants.

The performance of the strain No. 288 (*Dioscorea esculenta* var. *spinosa*) was significantly and markedly superior to that of the strain Jamani (*D. alata*).

INTRODUCTION

Cultural practices exhibit a greater degree of diversity in Ceylon than in countries with settled agricultural traditions, and local planting methods with yams (*Dioscorea* Spp.) lack the uniformity that one would expect of a crop which is native to the Eastern Tropics, and which has probably been in cultivation in this country for several hundred years. Yams, along with other root crops, have assumed tremendous importance in war time, and the need for exact information on the relative efficiency of various planting methods is urgent.

Most cultivated yams fall into the two species, *Dioscorea alata* Linn. (the Greater Yam) and *D. esculenta* Burkill (the Lesser Yam).

D. alata possesses ridged or winged stems which twine to the right. The tubers vary considerably in shape. The tuber flesh may possess a magenta sap which oxidizes, on exposure to air, to a rusty brown. This pigment may extend to subaerial tissues. The leaves are subsagittate or subhastately ovate. Some races produce bulbils in quantity, others sparingly.

D. esculenta is a thorny climber twining to the left. Numerous stalked tubers are produced in relatively superficial clusters. The stems are cylindrical, and the leaves cordate. Two varieties are recognized, viz., *spinosa* in which the tubers are protected by mats of spinous roots, and *fasiculata* which does not possess spinous roots.

Cultivated dioscoreas vary in the depth of tuber formation. The fact is of some interest as the depth of tuber formation will be reflected in

planting-hole requirements and in the ease with which the crop can be lifted. Tuber formation is, as a rule, shallower in *D. esculenta*.

Seed rate, spacing and staking are some of the other factors which contribute to planting costs and which have been investigated in the experiment reported herein.

TREATMENTS

There were 32 treatments consisting of the following in all combinations.

(N)	Number of setts per hill	One sett per hill (N_0) or two setts per hill (N_1)
(S)	Spacing of hills	3 ft. by 3 ft. (S_0) or 3 ft. by 1½ ft. (S_1)
(D)	Depth of planting-hole	1 ft. (D_0) or 3 ft. (D_1)
(T)	Staking	Unstaked (T_0) or staked (T_1)
(V)	Variety	Jamani, a strain of *D. alata* (V_0) or No. 288, a strain of *D. esculenta* var. *spinosa* (V_1)

A single replication of 32 plots was distributed over four blocks of eight plots. Each plot had a nett harvested area of 1/134 acre (18 ft. by 18 ft.). Details of the design are given in Appendix 1.

MATERIAL AND METHODS.

In 1935, the Botanist imported five strains of *D. alata* from Fiji, viz., Jamani, Uvi-ni-vutuna, Taniela-vula-leka, Taniela-damu and Lantolu.

These strains were tested at Peradeniya in six seasons. Jamani proved to be the most delicately flavoured and was included in the present trial. The strain is white-fleshed. The external colour of the tuber is argus brown (Ridgway : III 13 m).

The Botanist's next importation of yams was in 1940, when the following five strains were obtained through the courtesy of the Adviser on Agriculture, S. S. and F. M. S., Kuala Lumpur.

Number.	Species.	Country of Origin.
10	*D. alata*	Philippines
30	,,	,,
48	,,	,,
408	,,	French Indo-China
288	*D. esculenta* var *spinosa*	,,

The performance of No. 288 was the most satisfactory of these five strains in the tests carried out in four seasons at Peradeniya, and warranted its retention in the present trial. The strain is white-fleshed. The external colour of the tuber is ochraceous buff (Ridgway : XV 15/6). No. 288 closely resembles the local *Kukul-ala* types.

The cultural experiment presented herein was set down at Peradeniya in the *yala* season, 1943. The soil of the experimental area was a moderately heavy loam slightly acid in reaction (pH=5·5). The land had been under tea in the immediate past. The area was ploughed and disced after the removal of the tea, and a dressing of 5 tons cattle manure per acre was applied.

Holes were dug on June 19, 1943. Holes in D_0 plots measured 1 ft. (deep) by 1½ ft. by 1½ ft., and those in D_1 plots measured 3 ft. (deep) by 1½ ft. by 1½ ft. The holes were filled with prepared soil, and four-ounce setts were planted in them at a depth of six inches, on June 28. N_0 and N_1 plots received one and two setts per hill respectively. T_1 plots were staked on August 2.

The following records of vine lengths were made in random samples in the various treatments on September 15 :—

Treatment.		Mean Length of Vine in ft.	Standard Error.
Jamani unstaked	(V_0 T_0)	6·4	±4·1
Jamani staked	(V_0 T_1)	12·9	±2·8
No. 288 unstaked	(V_1 T_0)	5·2	±2·0
No. 288 staked	(V_1 T_1)	13·8	±1·5

The difference between V_1T_0 and V_1T_1 is significant. In the instance of No. 288, unstaked plants exhibited, in addition to a significant shortening of the vines, a reduction in leaf size. No comparable difference in leaf dimensions between staked and unstaked plants was observed in Jamani.

On September 20, Jamani plants showed a severe spotting of leaves associated with the fungus, *Cercospora Dioscoreae* Ell. and Mart. The damage was particularly heavy on unstaked plants. No. 288 exhibited some degree of resistance.

The onset of senescence was earlier in unstaked plants. Jamani vines commenced dying on December 26, and those of No. 288 on January 15, 1944. The crop was lifted on January 26.

Records of monthly precipitation for the period of the experiment are given in Appendix 2.

RESULTS

The analysis of variance of weights of tubers produced in the various plots is given in Appendix 3. The superiority of No. 288 to Jamani is significant at the 0·1 per cent. point. The effects of spacing and staking are significant at the one per cent. point, and the effect of seed rate at the five per cent. point. The depth of planting-hole has had no significant effect. None of the first-order interactions attains significance.

The yield data are summarized in Table 1.

Table 1. Yields of Tubers in Tons per Acre.

		Number of Setts.		Spacing.		Staking.		Variety.		Mean Yield.
		One per Hill.	Two per Hill	3 ft. by 3 ft.	3 ft. by 1½ ft.	Unstaked	Staked	Jamani	No. 288	(—0·229)
Number of Setts	One per hill ..	—	—	1·93	2·54	1·67	2·80	1·32	3·14	2·23
	Two per hill ..	—	—	2·21	3·93	2·59	3·55	2·11	4·03	3·07
Spacing	3 ft. by 3 ft. ..	1·93	2·21	—	—	1·64	2·49	1·14	2·99	2·07
	3 ft. by 1½ ft. ..	2·54	3·93	—	—	2·61	3·86	2·29	4·18	3·24
Staking	Unstaked ..	1·67	2·59	1·64	2·61	—	—	1·10	3·15	2·13
	Staked ..	2·80	3·55	2·49	3·86	—	—	2·33	4·02	3·18
Variety	Jamani ..	1·32	2·11	1·14	2·29	1·10	2·33	—	—	1·72
	No. 288 ..	3·14	4·03	2·99	4·18	3·15	4·02	—	—	3·59

DISCUSSION

Probably the most striking feature of the results is the significant and overwhelming superiority of No. 288. The performance of No. 288 has always been consistently good. Average yields per plant in the years, 1940–42, are given below :

Year.	Yield per plant in lb.	
	Jamani.	No. 288.
1940	1·5 ..	6·8
1941	4·0 ..	4·3
1942	1·8 ..	4·3

Jamani is the finer flavoured of the two strains. The considerably reduced yields are, however, too heavy a price to pay for flavour.

In the instance of the vegetatively less vigorous strain, Jamani, the yields are almost exactly doubled at the closer spacing, *i.e.*, the yields per plant are almost identical at the two spacings. No competition effects are evident even at 3 ft. by 1½ ft., and the desirability of narrowing the spacing further may be profitably explored. Even with No. 288, the 3ft. by 1½ ft. spacing gives much higher yields, and is the obvious recommendation for this variety as well. It is not difficult to reconcile these results with the observations of Wood (1933) in Trinidad that the optimum spacing is in the neighbourhood of 5 ft. by 1 ft. Wood worked with " Lisbon ", a variety of *D. alata.*

In the instance of both Jamani and No. 288, heavier yields were obtained with the higher seed rate. Apart from heavier yields, the desirability of planting two setts per hill as a measure of insurance against vacant hills, is evident.

The use of deeper planting-holes has not resulted in higher yields. In view of the lower cost, shallow planting should be preferred.

The better performance of staked plants was anticipated, but the degree of this superiority was unexpectedly large. In the instance of the of the strain, Jamani, the average yield was more than doubled by staking. Higher yields in staked plants are usually attributed to the better orientation of the photosynthetic surface in relation to incident light. This cause does not appear to provide a complete explanation of the benefit of staking. In Jamani, leaves were distributed sparsely on the stem, and the degree of overcrowding and shading of leaves in plants that trailed on the ground, could not have been considerable. In the instance of Jamani, a factor that would have contributed to depressed yields in unstaked plants is the greater severity of *Cercospora* attack. It is perhaps unprofitable to speculate on the causes underlying the higher incidence of *Cercospora* on unstaked plants. Higher humidity and the greater availability of the spore inoculum may have been contributory factors.

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APPENDIX I.

Design of the Experiment

A factorial design by Yates (1937) of the form 2^5 was adopted. The 32 treatments (five factors each at two levels) were arranged in the following manner:—

BLOCK 1	BLOCK 2	BLOCK 3	BLOCK 4
1 1 1 1 1*	1 1 1 0 1	1 1 1 0 0	1 1 1 1 0
1 1 0 1 0	1 1 0 0 0	1 1 0 0 1	1 1 0 1 1
1 0 1 0 1	1 0 1 1 1	1 0 0 1 1	1 0 1 0 0
1 0 0 0 0	1 0 0 1 0	1 0 1 1 0	1 0 0 0 1
0 1 1 0 0	0 1 1 1 0	0 1 1 1 1	0 1 1 0 1
0 1 0 0 1	0 1 0 1 1	0 1 0 1 0	0 1 0 0 0
0 0 1 1 0	0 0 1 0 0	0 0 1 0 1	0 0 1 1 1
0 0 0 1 1	0 0 0 0 1	0 0 0 0 0	0 0 0 1 0

The three interactions N. S. T., N. D. V., and S. D. T. V. were confounded with the four blocks. For further details of the design, reference may be made to Yates (1937).

* The levels of the five factors in each treatment combination are given in succession, *e. g.*, 11010 indicates. $N_1S_1D_0T_1V_0$.

APPENDIX II.

Rainfall for period June, 1943–January, 1944.

Month.	Total precipitation in inches.	Number of Rainy Days.
June, 1943	12·84	21
July	7·73	15
August	4·04	13
September	3·87	13
October	12·53	23
November	17·45	17
December	7·22	8
January, 1944	3·71	8

APPENDIX III.

Analysis of Variance of Plot Yields.

	DF.	SS.	MS.
Blocks	3	2975·34	991·78
Main Effects and Two-Factor Interactions	15	15971·47	1064·76
Error	13	2781·41	213·95
Total	31	21728·22	