CULTURAL EXPERIMENTS WITH CASSAVA (*MANIHOT UTILISSIMA POHL—I.*)

M. FERNANDO, Ph.D., B.Sc. (Lond.), D.I.C.,
ACTING BOTANIST

AND

E. S. JAYASUNDERA, Dip. Agric. (Poona),
MANAGER, EXPERIMENT STATION, ANURADHAPURA

SUMMARY

A TRIAL was set down at the Experiment Station, Anuradhapura, for the purpose of determining the effect of length and orientation of cutting, spacing and tiller number on the yield of two varieties of cassava.

2. Plants derived from eighteen-inch cuttings significantly outyielded plants derived from six-inch cuttings.

3. The superiority of vertical planting over horizontal planting was significant at the odds of 99 to 1. The latter method, apart from depressing the yield per plant, resulted in lower percentage survival.

4. There were no significant differences in yield between the two varieties, A. 3.7 and B. 4.1, and between the two spacings, 3ft. by 3 ft. and 3 ft. by 2 ft.

5. The thinning of tillers to one per plant did not affect the yield significantly.

INTRODUCTION

Cassava (*Manihot utilissima* Pohl) has always been the most widely cultivated root-crop in the villages in Ceylon, and has assumed, in war-time, tremendous importance as a "famine" crop. With the considerable extension of the acreage under the crop, the demand for more exact information on cultural methods has become urgent. Methods of cassava culture have been the subject of investigation by the Botanist, Department of Agriculture, for some time. The results of an experiment that aimed at determining the effect of length and orientation of cutting, spacing and tiller number on the yield of cassava varieties are, presented herein.

TREATMENTS

There were 32 treatments, consisting of the following, in all combinations :

(V) Variety : A. 3.7 (V_0) or B. 4.1 (V_1).

(L) Length of cutting : 6 inches (L_0) or 18 inches (L_1).

(S) Spacing : 3 ft. by 3 ft. (S_0) or 3 ft. by 2 ft. (S_1).

(O) Orientation of cutting : cutting planted horizontally (O_0) or vertically (O_1).

(N) Number of tillers : plant allowed to develop all the tillers that appear (N_0) or only one tiller (N_1).

A single replication of 32 plots was distributed over four blocks of eight plots. The plots measured 24 ft. by 18 ft. (1/100 acre).

Details of the design are given in Appendix 1.

MATERIAL AND METHODS

Summary descriptions of the varieties under test are given below :

V_0 : Serial number, A. 3.7 ; local variety originally obtained from Paranthan ; local name *manyokka* ; petiole yellowish-green with faint rose shading at distal end ; young leaf purplish-brown with yellowish-green midrib ; stem bright green, becoming silver-grey when mature ; tuber short and stout ; outer skin of tuber buff or dirty white, with occasional dark grey patches ; inner skin light yellow ; flesh yellow ; branching low ; foliage dense ; perianth of male flowers cream with faint rose shading ; perianth of female flowers cream with alizarine pink stripes ; stigma very pale pink ; ovary green with pink ridges ; flowers of both sexes bloom almost simultaneously.

V_1 : Serial number B. 4.1 ; local variety originally obtained from Matugama ; local name *demas manyokka* ; petiole carmine red ; young leaf purplish-green with red midribs ; stem bright green with five red stripes, turning silver-grey when mature ; tuber short and stout ; outer skin of tuber buff or salmon, scaly ; inner skin light yellow ; flesh yellow ; branching variable ; foliage dense ; perianth of male flower bright green with red shading ; perianth of female flower light green with red stripes and shading ; stigma cream ; ovary green with pink ridges ; flowers of both sexes bloom almost simultaneously ; male flowers more numerous.

Planting material of both these varieties had been raised at the Experiment Station, Nugawela.

The trial was set down at the Experiment Station, Anuradhapura, in the *maha* season, 1940–41. The soil was a chocolate

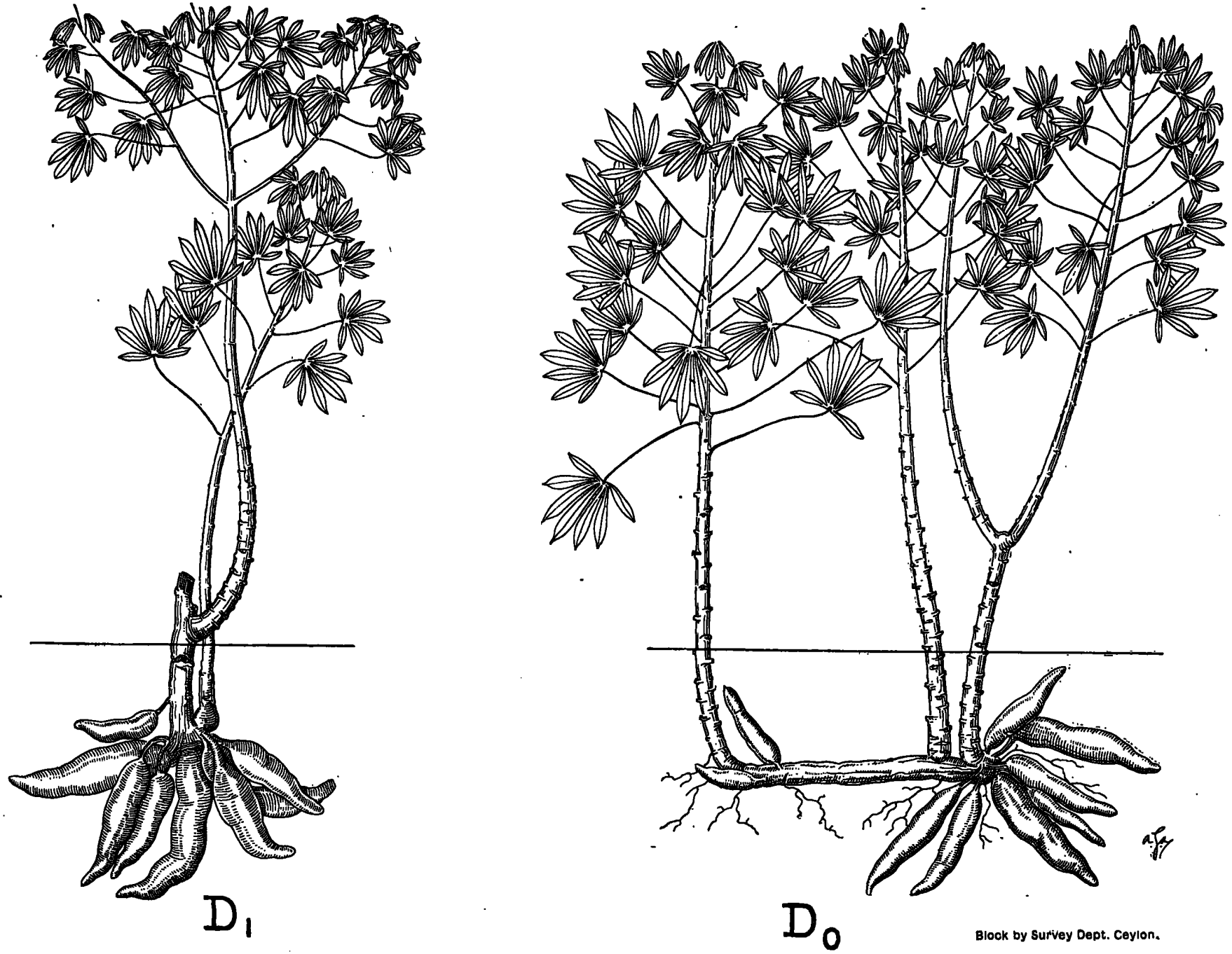

Fig. 1.—Illustrating the habit of plants derived from cuttings placed vertically (D_1) and horizontally (D_0).

brown loam which, on account of its high content in exchangeable bases, was decidedly alkaline in reaction. The experimental area had carried a crop of green gram in the previous *yala*, and had subsequently been ploughed, disc-and tooth-harrowed in the manner usual on Departmental stations. Cuttings were planted on October 10, 1940. Despite careful planting, one or two cuttings in the 0_1 plots had been placed the wrong way up ; in tender cuttings, the locating of axillary buds is often difficult.

Sprouting of some of the vertically placed cuttings was observed four days after planting. Thinning of tillers in N_1 plots to one per plant commenced on November 14. The area received five weedings. Weed infestation was heavier in 0_0 plots evidently as a result of the later sprouting. The crop was lifted on March 19, 1941. The nett harvested area in each plot was 18 ft. by 12 ft. (1/200 acre). Meteorological data for the experimental season are given in Appendix 2.

RESULTS

Cuttings placed vertically sprouted earlier than cuttings placed horizontally. In the instance of the vertical planting, sprouting was somewhat earlier in the shorter cuttings. Cuttings placed vertically died back to the point of origin of the first tiller (Fig. 1). This die-back did not, however, appear to affect the plant adversely. Considerably larger numbers of vacancies were recorded in the instance of the shorter cuttings and of cuttings orientated horizontally.

The analysis of variance of the yields of tubers in plots subjected to the various treatments is given in Appendix III. The effects of the orientation of the cutting, and of the length of the cutting, are significant at the one and five per cent. points respectively. There is no significant difference in performance between the two varieties. Spacing and the reduction of the tiller number to one per plant have not produced significant effects. The interaction between spacing and length of cutting is the only one that reaches significance.

The yields and the percentages of surviving plants in plots subjected to the various treatments are given in Table I.

TABLE I.

Treatment.	Yield in lb. per acre.	Percentage Survival.
1. *Variety* :—		
A. 3.7	8254 ..	82.1
B. 4.1	8394 ..	83.3
2. *Length of cutting* :—		
6 inches	7612 ..	71.4
18 inches	9037 ..	93.9

Treatment.	Yield in lb. per acre.	Percentage Survival.
3. *Spacing :—*		
3 ft. by 3 ft.	7924 ..	81.2
3 ft. by 2 ft.	8724 ..	83.7
4. *Orientation of Cutting :*		
Horizontal	6556 ..	76.2
Vertical	10093 ..	89.2
5. *Number of Tillers :—*		
Unlimited	8384 ..	82.3
One	8264 ..	83.1

The analysis of variance of percentage stand, transformed to the inverse-sine scale appropriate to the binomial distribution, did not reveal significant effects in the instance of any of the treatments. It is accordingly difficult to evaluate the degree to which the larger numbers of casualties would have depressed the yields of L_0 and O_0 plots.

DISCUSSION

Despite the importance of the crop, the volume of relevant published work is not large. In the Philippines, Mendiola (1931) recommends the use of mature cuttings 25–30 cms. long, a planting distance of 75–100 cms., and either vertical or oblique planting. Greenstreet and Lambourne (1933) provide a detailed account of cultural practices in Malaya. In that country, cassava is planted in smallholdings and in market gardens, either on the flat or in ridges. Ridges are spaced four feet apart ; the spacing of plants on the ridge is 2½–3 ft. On the flat, the spacing may be as close as 3 ft. by 2 ft. When cassava is raised as a catch crop in young rubber, the planting distance is roughly 4–5 ft. by 5 ft. Spacing in unstumped land is necessarily irregular. Mature stems—the woody bases and tender apices are discarded—are cut into 5–6 inch sections. Most growers, particularly the Chinese, bury the cuttings horizontally just below ground level. Javanese and Malays, however, plant cuttings vertically or obliquely. Greenstreet and Lambourne (l.c.) report the failure, in Java, to obtain increased yields by thinning the plants to a single stem.

A diversity of opinion exists with regard to the best orientation of the cutting. None of the practices described above has, however, been based on the results of exact field experiments. *The demonstration, in the experiment presented herein, of the significant superiority of vertical planting, at least under unirrigated conditions in the dry zone, is accordingly of considerable interest. Horizontal planting not only depresses the yield per plant, but results in lower percentage survival of the cuttings.*

The undesirability of using cuttings as short as six inches is evident in this experiment. It has been shown in an experiment, which will be reported in a later number of this series, that the optimum length of cutting is approximately nine inches.

Although the wider spacing, 3 ft. by 3 ft., and the practice of leaving the tillers unthinned did not reduce yields, it may be suggested that, if the difference between spacings had been larger, both the effect of thinning tillers to one per plant and the interaction between thinning and spacing might have attained significance.

ACKNOWLEDGEMENT

We are grateful to Dr. J. C. Haigh, Botanist, for valuable advice during the course of the work, and to Mr. K. D. S. S. Nanayakkara, Assistant in Economic Botany, for the descriptions of the two cassava varieties.

REFERENCES

Fisher, R. A., and Yates, F., 1938 — Statistical Tables for Biological, Agricultural and Medical Research. *London: Oliver and Boyd.*

Greenstreet, V. R., and Lambourne, J., 1933 — Tapioca in Malaya. *Dept. of Agric., S. S. and F. M. S., Bull. No. 13 (General Series).*

Mendiola, N. B., 1931 .. — Cassava Growing and Cassava Starch Manufacture. *Philippine Agriculturist XX: pp. 447–476.*

Yates, F., 1937 .. — The Design and Analysis of Factorial Experiments. *Imperial Bureau of Soil Science Tech. Comm. No. 35.*

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, V.L.O., V.S.N. and L.S.O.N. 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.*, 1 1 0 1 0 indicates $V_1L_1S_0O_1N_0$.

APPENDIX II.

Meteorological Data.

Month.	Temperature.				Humidity.		Rainfall.		
	Mean Maximum.	Difference from Average.	Mean Minimum.	Difference from Average.	Day.	Night.	Amount.	No. of Rainy days.	Difference from Average.
	°F	°F	°F	°F	Per cent.	Per cent.	Inches.		Inches.
September	94·5	+3·6	75·3	+0·5	59	91	9·78	8	+5·87
October	88·4	−0·5	73·6	+0·2	78	93	14·20	19	+4·43
November	85·8	+0·4	73·3	+1·7	83	95	7·47	24	−4·07
Dec., 1940	83·8	+0·9	72·7	+3·1	83	95	4·06	21	−3·55
Jan., 1941	84·5	+1·7	72·3	+3·4	78	95	4·33	15	−1·38
February	86·8	0	71·3	+2·0	75	95	2·53	7	+1·04
March	92·4	+1·5	72·7	+1·2	59	93	3·09	6	−0·55

APPENDIX III.

Table 1. Analysis of Variance of Yields.

	D. F.	S. S.	M. S.
Main Effects :			
V	1 ..	3·85 ..	3·85
L	1 ..	399·74 ..	399·74
S	1 ..	126·01 ..	126·01
O	1 ..	2462·27 ..	2462·27
N	1 ..	2·82 ..	2·82
Interactions :			
V. L	1 ..	0·26 ..	0·26
V. S	1 ..	17·26 ..	17·26
V. O	1	187·70 ..	187·70
V. N	1 ..	2·05 ..	2·05
L. S	1 ..	388·51 ..	388·51
L. O	1 ..	73·51 ..	73·51
L. N	1 ..	33·01 ..	33·01
S. O	1 ..	166·99 ..	166·99
S. N	1 ..	42·55 ..	42·55
O. N	1 ..	80·96 ..	80·96
Main Effects and Interactions ..	15 ..	3987·47 ..	265·83
Blocks	3 ..	— ..	—
Remainder	13 ..	710·29 ..	54·64
Total ..	31		