

## GINGER MANURIAL AND CULTURAL EXPERIMENTS

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### INTRODUCTION

**I**N the May 1933 issue of this Journal an account was given of preliminary manurial trials carried out with ginger at Siyambalagoda in the Kandy district. The results obtained were so encouraging that it was decided to continue these trials on a more extensive scale. In addition to manurial experiments, varietal trials and experiments to determine the optimum seed rate for ginger and the best method of planting the crop for curing purposes were included in the experimental programme. The new trials were carried out at Giragama about five miles from Peradeniya in the centre of a ginger growing area. The experimental area was a fairly steep hillside, undulating in parts, but typical of ginger growing land in the Province. Plates I and II will give some idea of the nature of the land under experiment.

### MANURIAL AND VARIETAL TRIALS

The manurial experiments were designed to determine (1) which of two varieties (the local and the Nugegoda—a degenerated type of Cochin ginger) was the better yielding, (2) the effect of manuring on yields and the relative efficacies of artificial and cattle manure on each variety, (3) the effect of liming, (4) the effect of a mulch of straw, and (5) the interaction between the various factors concerned.

### DESIGN

The randomised block method of field experimentation was adopted owing to the large number of treatments involved and the varying configuration of the land. Three blocks each containing 24 randomised plots, one for each treatment, were

marked out so that, as far as possible, each plot ran down a slope of the hillside. This would be apparent from Plates I and II. The plots in a block were separated from each other by a drain one foot wide and four inches deep. Owing to the nature of the land the plots could not all have been of one shape, but they were all of the same size viz. 450 sq. ft. or one-ninety third of an acre approximately.

### SOIL

The area had been uncultivated for several years and was thick with weeds prior to cultivation. The analysis of a representative sample of soil from the area, seen in Table I below, shows that it is a silty loam, well supplied with nitrogen and organic matter, and acidic in reaction. Due to its high clay content, it should be well supplied with potash. Compared with local soils it is definitely fertile and the comparatively high yield obtained from the control plots is therefore not surprising.

TABLE I

*Mechanical Analysis*

	%
Moisture	2.73
Coarse sand	21.75
Fine sand	24.87
Silt	27.50
Clay	21.25
Sesquioxides, etc.	.88
Difference	1.02
	100.00

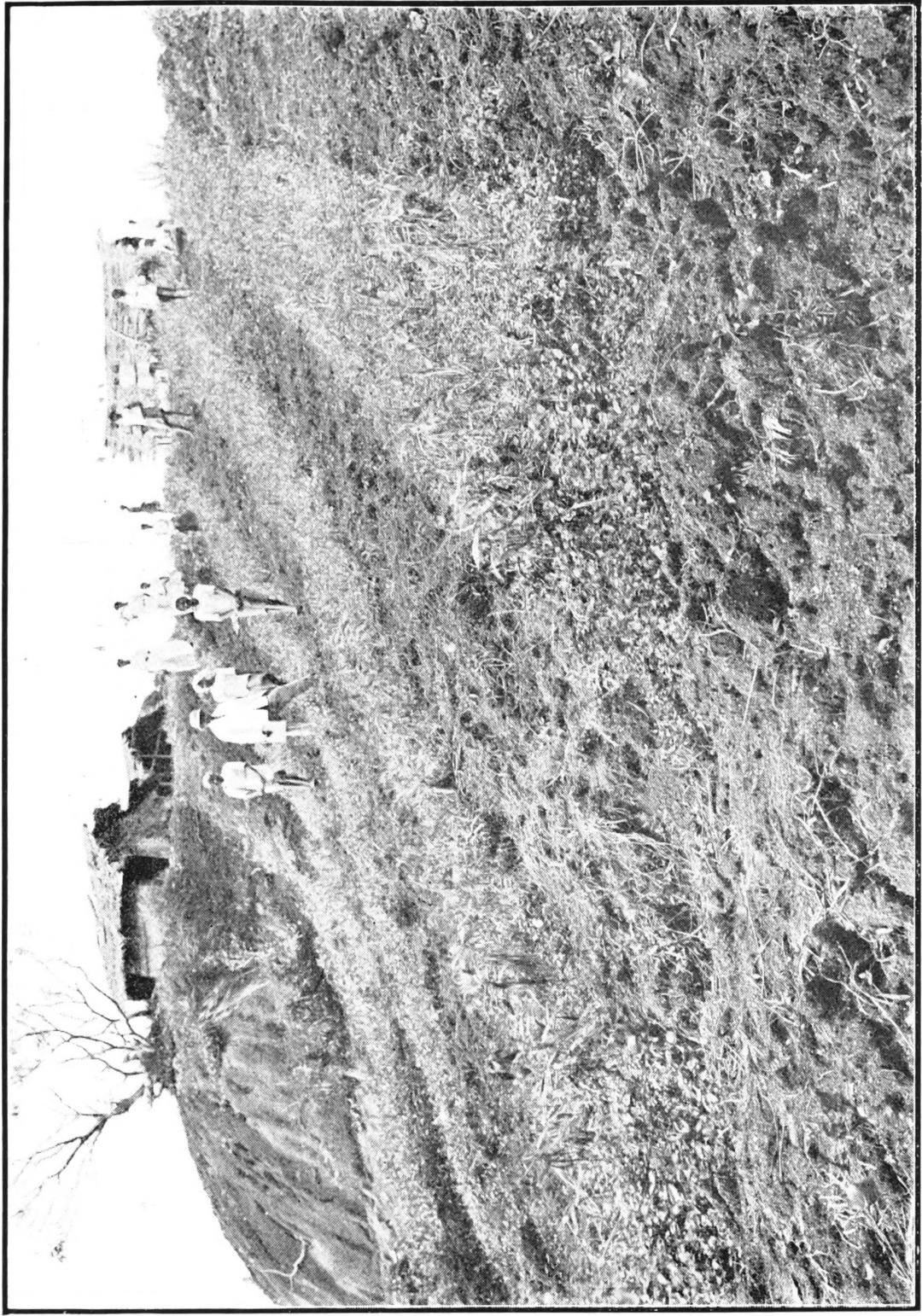
*Chemical Analysis*

Nitrogen	.137
Loss on ignition	11.56
Reaction (PH)	6.5

### TREATMENTS

The number of treatments was 24, made up of combinations of the following:

Varieties	2—Nugegoda and local ginger
Manurial treatments	3—{ No manure Cattle manure Artificial manure
Liming	2—{ No liming Liming
Cultural treatments	2—{ No mulch Straw mulch



*Photo.* Plate I. The nature of the land under experiment *L. S. Bertus*

Though there were only three replications of each treatment, the number of effective replications for comparisons of means of major treatments was considerably higher. Thus in the case of varieties the means of 36 plots are compared. So also with the comparison of liming against no liming and mulching against no mulch. Comparisons of the three manurial treatments are based on the means of 24 plots.

The complete set of treatments is shown in Table II below. In this and subsequent tables *N* will signify Nugegoda ginger, *G* local or Giragama ginger, *S* straw mulch, *L* lime, *C* cattle manure, and *A* artificial fertilisers.

TABLE II

*Treatments*

Number					Designation
1	Nugegoda	No manure	No lime	No straw	N
2	"	"	"	Straw	N S
3	"	"	Lime	No straw	N L
4	"	"	"	Straw	N L S
5	Local	"	No lime	No straw	G
6	"	"	"	Straw	G S
7	"	"	Lime	No straw	G L
8	"	"	"	Straw	G L S
9	Nugegoda	Cattle manure	No lime	No straw	N C
10	"	"	"	Straw	N S C
11	"	"	Lime	No straw	N L C
12	"	"	"	Straw	N L S C
13	Local	"	No lime	No straw	G C
14	"	"	"	Straw	G S C
15	"	"	Lime	No straw	G L C
16	"	"	"	Straw	G L S C
17	Nugegoda	Artificial manure	No lime	No straw	N A
18	Nugegoda	Artificial manure	No lime	Straw	N S A
19	"	"	Lime	No straw	N L A
20	"	"	"	Straw	G L S A
21	Local	"	No lime	No straw	G A
22	"	"	"	Straw	G S A
23	"	"	Lime	No straw	G L A
24	"	"	"	Straw	G L S A

### PLANTING DETAILS

Lime was applied on the limed plots at the rate of 15 cwt. per acre three weeks before planting. Cattle manure was forked in at the rate of 2 cwt. per plot or 9.3 tons per acre, a day or two before planting. The artificial fertilizer consisting of a mixture of equal parts of sulphate of potash, sulphate of ammonia and superphosphate was applied at the rate of 6 lb. per plot or approximately 5 cwt. per acre, a day before planting. The seed ginger was divided into small sets and planted in holes 18 inches apart at the rate of 15 lb. per plot, there being 240 holes to a plot. The seed rate was therefore about 12.5 cwt. per acre. Paddy straw was used as a mulch at the rate of 15 bundles or about 40 lb. per plot, equivalent to 35 cwt. per acre.

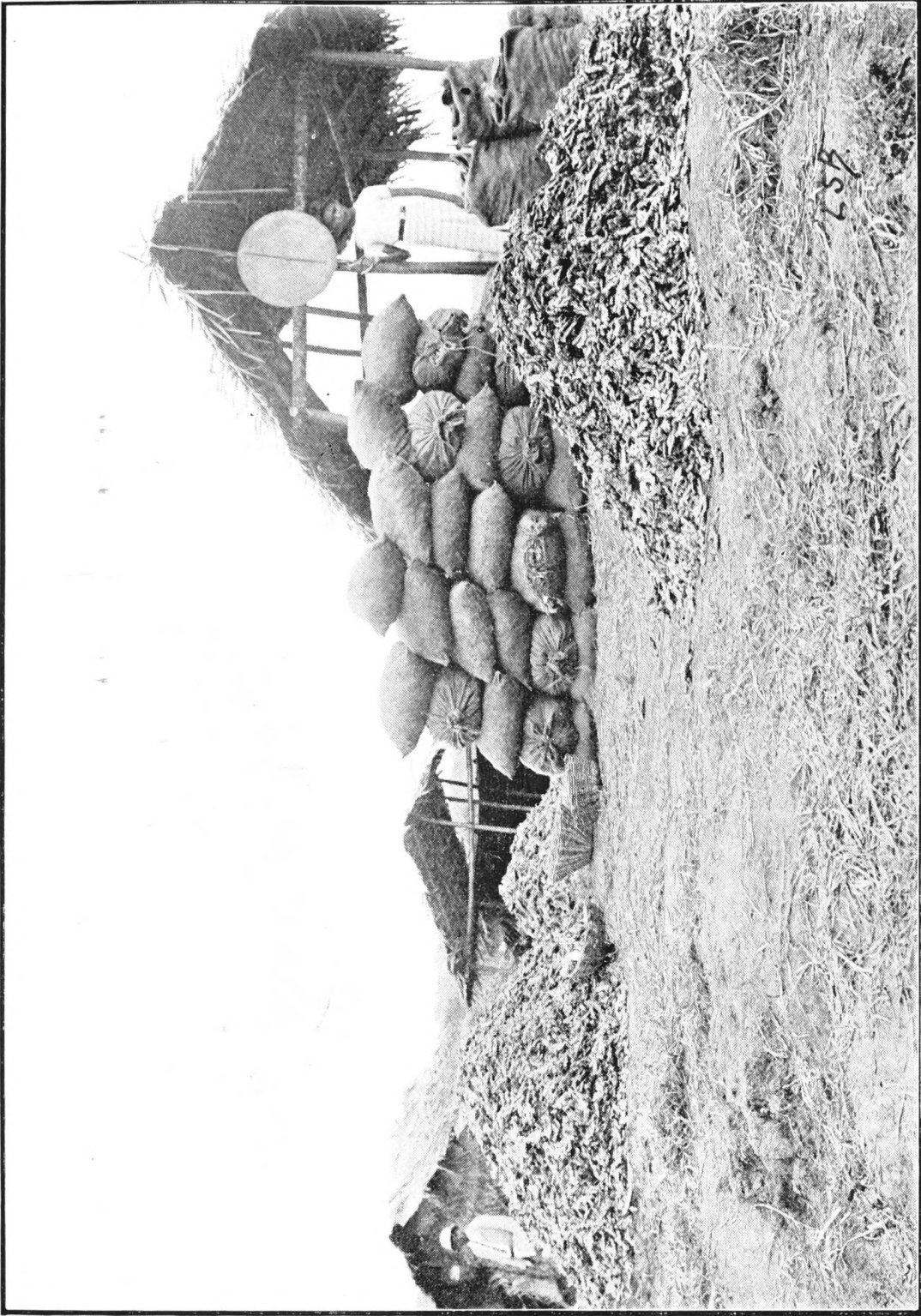
The area had previous to blocking been mamoty-dug twice. Weeding was carried out periodically. The crop was planted between the 26th and 28th April, 1933 and harvested between the 8th and 12th January, 1934. Owing to the heavy rainfall conditions experienced throughout the growing period, a few of the sets were affected by a rot caused by *Rhizoctonia solani* and *Pythium* spp. These were taken in hand by the Mycologist in good time and no further trouble was experienced. The results shown in Table III are actual weights of ginger obtained per plot and are not corrected for losses due to disease. Each plot was separately harvested, care being taken that as few rhizomes as possible were left in the soil. The rhizomes were carefully washed without delay and weighed as soon as the wash water had drained off.

Table III shows the actual weights of green ginger in lb.

A glance at this table will show the great variation in yields due to the different treatments. The mean yield varies from 117.8 lb. in the Nugegoda untreated plots to 184.8 lb. in the local artificially manured and mulched plots, a variation of 44.7 per cent. on the average yield. The table also brings out clearly the variation in block yields. Block C which has the steepest gradient and hence the greatest erosion, registers the lowest yield, while block A which is most favourably situated shows the highest total yield, the yield variation between the two being nearly 33 per cent. of the general mean.

### ANALYSIS OF DATA

The statistical analysis of variance of the data indicates that the yield differences due to variety, manuring and mulching are definitely significant, while those due to lime and the interactions



*Photo.*

Plate II. The harvested ginger

*L. S. Bertus*

TABLE III

*Yields per plot in lb. of raw ginger*

Treatments	Blocks			Total	Mean
	A	B	C		
1. N	150.5	120	83	353.5	117.8
2. NS	151	123	118	392	130.7
3. NL	142.5	100	111	353.5	117.8
4. NLS	191.5	121	97.5	410	136.7
5. G	142	166	106	414	138.0
6. GS	167	170	132	469	156.3
7. GL	142.5	142.5	106	391	130.3
8. GLS	130.5	149.5	128	408	136.0
9. NC	166.5	149	103	418.5	139.5
10. NSC	195	144.5	117.5	457	152.3
11. NLC	180	171	81.5	432.5	144.2
12. NLS C	237.5	184.5	121	543	181.0
13. GC	236	150.5	148	534.5	178.2
14. GSC	182	163.5	154	499.5	166.5
15. GLC	150.5	175.5	100	426.0	142.0
16. GLS C	152.5	202.5	156.5	511.5	170.5
17. NA	169	162.5	102.5	434	144.7
18. NSA	182.5	163	121	466.5	155.5
19. NEA	153.5	140	107	400.5	133.5
20. NES A	201	189.5	111	501.5	167.2
21. GA	155	153.5	118	426.5	142.2
22. GSA	178.5	206	170	554.5	184.8
23. GLA	155.5	158	147.5	461.0	158.6
24. GLS A	183	195	170	548	182.7
Total	4095.5	3800.5	2910	Grand Total	10.806
				General Mean	150.085

between the different factors concerned with yield, are not significant. The yield results for each of the different treatments are summarised in Tables IV to VIII below and are shown graphically in Plate III. The figures represent the amounts of green ginger.

TABLE IV

*Effect of Variety*

	lb. per plot	cwt./acre	tons/acre	% of mean
Nugegoda (average of 36 plots)	143.4	119.1	5.95	95.5
Local (average of 36 plots)	156.8	130.2	6.50	104.5
Difference	13.4	11.1	0.56	9.0
<b>Significant difference (P = .01)</b>	<b>13.3</b>	<b>11.1</b>	<b>0.56</b>	<b>9.0</b>

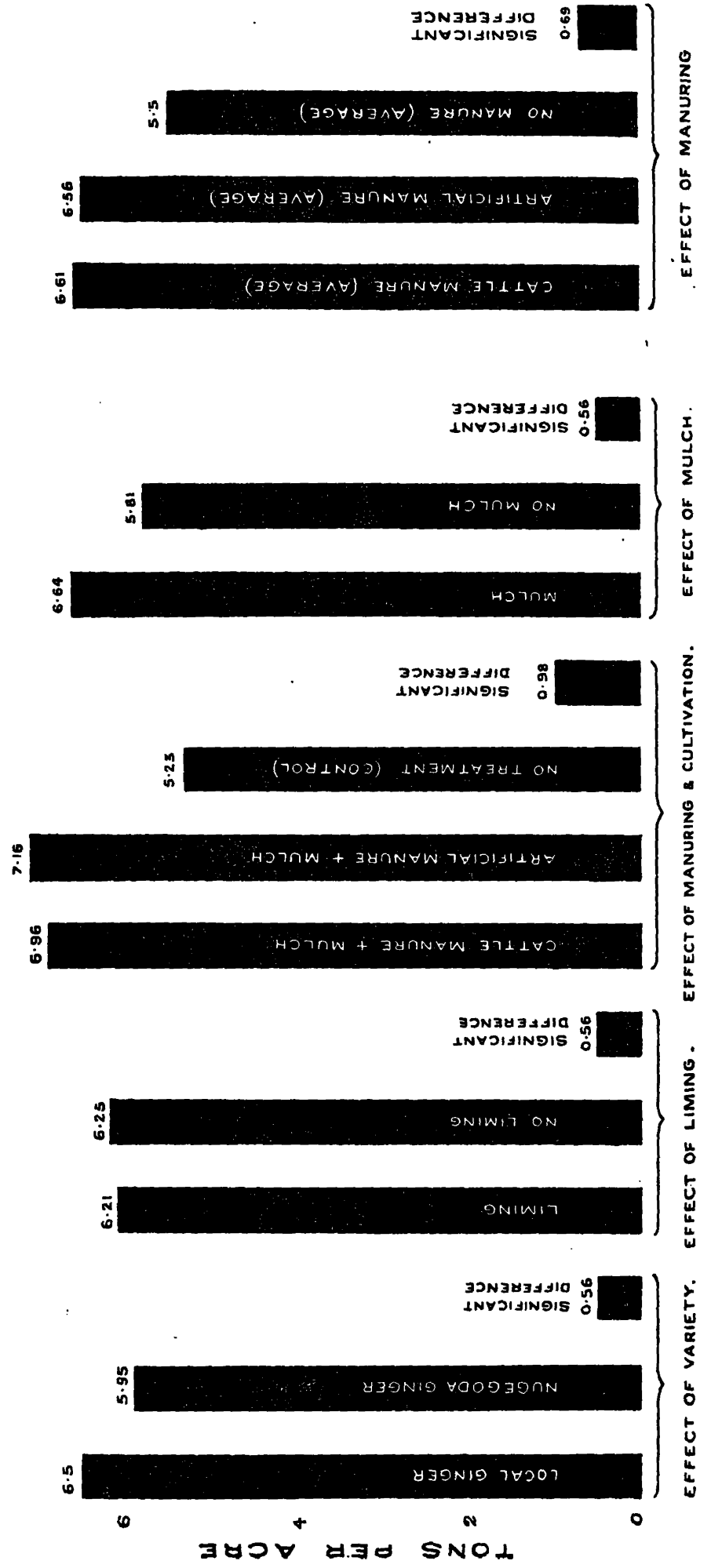
# GINGER MANURIAL AND CULTURAL TRIALS

GIRAGAMA

1933 - 1934.

YIELDS IN TONS PER ACRE.

8



Local ginger is therefore a significantly better yielder than Nugegoda ginger, the probability being 100 to 1 of this being so. An increase of over half a ton per acre or 9 per cent. is obtained under the conditions of the experiment, the general average yield being 6.23 tons per acre.

TABLE V

*Effect of Manuring*

	lb. per plot	cwt./acre	tons/acre	% of mean
1. No manure (average of 24 plots)	133.0	110.4	5.50	88.6
2. Cattle manure (average of 24 plots)	159.3	132.2	6.61	106.1
3. Artificial manure (average of 24 plots)	158.0	131.2	6.56	105.5
Difference between 2 & 1	26.3	21.8	1.09	17.5
„ „ 3 & 1	25.0	20.8	1.04	16.7
„ „ 2 & 3	1.3	1.0	0.05	0.8
<b>Significant difference (P = .01)</b>	<b>12.4</b>	<b>13.9</b>	<b>0.69</b>	<b>11.2</b>

The above table indicates that manuring with cattle manure and artificials at the rates stated produces definitely significant increased yields, the probability being over 100 to 1 that this is actually the result of the treatments. The increases in each case are just over a ton of green ginger per acre or about 17 per cent. of the mean yield. The difference between the average yields from the two types of manuring at the rates applied is wholly insignificant. This result is not unexpected as the cattle manure used at Giragama contained on the average .33 per cent. potash, equivalent to about 70 lb. per acre, while the artificial mixture contained about 89 lb. per acre of this constituent. On the other hand the organic matter of the cattle manure and its higher nitrogen content (.4 per cent or 83 lb. per acre against 37 lb. in the artificial mixture) would tend to counterbalance any increased yield differences which the higher potash content of the artificial mixture would give.

It would be interesting here to compare the above yield data with those obtained previously at Siyambalagoda. The control plots at Siyambalagoda gave an average yield of 4.53 tons per acre and the complete mixture plots 8.72 tons per acre, against yields of 5.50 and 6.56 tons respectively at Giragama. The higher yields obtained from the completely manured plots last year can almost entirely be attributed to the much larger quantity of fertiliser applied. The rate of application of the

mixed fertiliser was then 15 cwt. per acre against 5 cwt. on this occasion. On the other hand the control plots gave a higher average yield this year. This is mainly due to the Giragama soil having been uncultivated for a long time and being much richer in fertilising constituents than the Siyambalagoda soil, and to a lesser extent to the fact that the control figure in Table V represents the average of all plots without manure including those which had been mulched. The importance of the soil factor in ginger yields is therefore apparent.

Another point of note is the relative accuracies of the two manurial trials. The standard error of the mean treatments at Siyambalagoda was 9.7 per cent. or .58 tons per acre and the significant difference for a 100 to 1 probability 41.8 per cent. or 2.5 tons. At Giragama for comparisons between manurial treatments the standard error was as low as 2.9 per cent. or .18 tons with a significant difference of 11.2 per cent. or .69 tons. The accuracy of this experiment is therefore seen to be nearly four times that of the previous one and can be attributed largely to the much greater number of replications involved.

TABLE VI

*Effect of Liming*

	lb. per plot	cwt./acre	tons/acre	% of mean
Limed plots (average of 36)	149.6	124.2	6.21	99.7
Non-limed plots (average of 36)	150.5	125.0	6.25	100.3
Difference	0.9	0.8	0.04	0.6
<b>Significant difference (P = .01)</b>	<b>13.3</b>	<b>11.1</b>	<b>0.56</b>	<b>9.0</b>

It will be noted from the above table that the differences due to lime are wholly insignificant. Liming would therefore appear to be unnecessary for ginger even when the crop is grown on acid soils. On examining the data of the limed plots in greater detail, it is noted that whilst the Nugegoda variety shows an increase of 5.5 cwt. per acre as a result of liming, the local variety registers a decrease of 7.1 cwt. These differences are not however significant.

TABLE VII

*Effect of Mulching*

	lb. per plot	cwt./acre	tons/acre	% of mean
Mulched plots (average of 36)	160.0	132.8	6.64	106.6
Non-mulched plots (average of 36)	140.1	116.3	5.81	93.4
Difference	19.9	16.5	0.83	12.2
<b>Significant difference (P = .01)</b>	<b>13.3</b>	<b>11.1</b>	<b>0.56</b>	<b>9.0</b>

A mulch of straw is seen to be definitely beneficial for ginger, an increase of 16·5 cwt. per acre or 12·2 per cent. of the mean yield being obtained by this agricultural treatment. The reasons for the increase are twofold. There is in the first instance the physical effects of the mulch on moisture conservation and check to weed growth. The season having been a very wet one, the effect of the mulch on water conservation was of little importance. A more important reason for the increase is probably connected with the chemical and biological effects of decomposed straw. Owing to optimum moisture conditions for decomposition, the straw had broken down almost completely in the short period of about two months and the mulched plots had doubtless derived the fullest benefits therefrom. Paddy straw contains about 35 per cent. of organic matter and 1·5 per cent. of potash. At the rates applied, the amounts of organic matter contributed by the decomposed straw mulch would be approximately 1,370 lb. and of potash about 58·5 lb. per acre. This amount of potash alone would account for an appreciable increase in yield. An experiment to determine which of the two sets of factors concerned contributes more to increased yield has been laid out at the School Farm, Peradeniya this season.

In Table VIII below are shown the effects of manuring and cultivation. As liming has been found to have had no influence on yields, the yields of the limed plots are reckoned along with those of the non-treated or mulched plots as the case may be.

TABLE VIII

*Effect of Manuring and Mulching*

	lb. per plot	cwt./ acre	tons/ acre	% of mean
1. No treatment (average of 12 plots)	126·0	104·6	5·23	73·4
2. Cattle manure alone (average of 12 plots)	151·0	125·5	6·28	100·0
3. Artificial manure alone (average of 12 plots)	143·5	119·2	5·96	95·6
4. Cattle manure + mulch (average of 12 plots)	167·6	139·2	6·96	111·7
5. Artificial manure + mulch (average of 12 plots)	172·5	143·2	7·16	114·9
Difference between 2 & 1	25·0	20·9	1·04	16·6
„ „ 3 & 1	17·5	14·6	0·73	11·8
„ „ 4 & 1	41·6	34·6	1·73	38·3
„ „ 5 & 1	46·5	38·6	1·93	41·5
„ „ 4 & 5	4·9	4·0	0·20	3·2
<b>Significant difference (P = ·01)</b>	<b>23·7</b>	<b>19·7</b>	<b>0·98</b>	<b>15·8</b>

A glance at this table will show that by artificial manuring and mulching an increase of 38·6 cwt. or nearly 2 tons of green ginger per acre was obtained over non-manured and non-mulched ginger. Cattle manure and mulching at the rates applied gave an increase of about 34·6 cwt. The small difference between the two combined treatments is not at all significant. Cattle manure alone gave an increase of about 21 cwt. and artificials alone about 14·5 cwt. per acre.

Though it would appear from the table that the effect of mulching is greater with artificials than with cattle manure, the detailed statistical analysis indicates that there is no significant differential response of mulching to manurial treatments. The only correct conclusion that could be drawn from the data is that mulching and manuring, singly and conjointly produce significant increased yields. There would however appear to be some indication that when cattle manure is used for manuring ginger, mulching is not so necessary as when artificials alone are applied.

#### **ECONOMICS OF MANURING AND CULTIVATION**

The data shown in Tables VII and VIII may be used to determine the relative economic returns from the various types of manuring and cultivation. In the balance sheet shown in tabular form below the cost of straw is reckoned at 50 cents a cwt., a low grade material being sufficient for the purpose. The cattle manure is valued at Rs. 2/- per cartload or Rs. 4/- per ton of two cartloads. The price of ginger is reckoned at Rs. 2/- per cwt.

It will be seen from the above table that the application of cattle manure and artificials along with straw will be productive of increased profits in the neighbourhood of Rs. 20/- per acre, if raw ginger is reckoned at Rs. 2/- per cwt. Where cattle or artificial manure alone is used, no increased profits are obtained at this price of ginger. The reverse appears to be the case. The nett returns shown in the table will however vary to some extent.

From the results of this experiment, and with ginger at a price of Rs. 2/- per cwt, it may be concluded that the manuring of ginger grown on virgin soils with artificials or cattle manure alone, will not be conducive to increased profits. Accompanied with mulching, however, increased profits can be secured even on these soils. On poor eroded soils, on the other hand, as at Sivambalagoda, manuring will appear to be definitely beneficial. Mulching alone has given an increased profit of about Rs. 20/- per acre even on fertile soil.

TABLE IX

	Increase over control : cwt. raw ginger per acre	Amount of manure or straw per acre	Cost of manure including freight	Cost of straw	Cost of application	Total cost of treatment	Value of ginger	Difference between last two columns
1. Cattle manure + mulch	34.6	9.2 tons	Rs. 36.80	Rs. 17.50	Rs. 5.00	Rs. 59.30	Rs. 69.20	+ Rs. 19.90
2. Artificial manure + mulch	38.6	5 cwt.	„ 34.50	„ 17.50	„ 5.00	„ 57.00	„ 77.20	+ „ 20.20
3. Cattle manure alone	20.9	9.2 tons	„ 36.80	—	„ 3.00	„ 39.80	„ 40.80	+ „ 1.00
4. Artificial manure alone	14.6	5 cwt.	„ 34.50	—	„ 3.00	„ 37.50	„ 29.20	- „ 8.30
5. Mulching alone	19.9	35 cwt.	—	„ 17.50	„ 3.00	„ 20.50	„ 39.80	+ „ 19.30

### CONCLUSIONS

It is recommended therefore that in all areas where ginger is grown, straw mulching be established as a definite practice, as even at a price of Rs. 1/50 per cwt. of raw ginger an increased profit can be assured. When prices are about Rs. 2/- per cwt, mulching and manuring with artificials are recommended. A mixed fertiliser is advisable, but the application of about 200 lb. per acre of sulphate or muriate of potash alone will be beneficial if accompanied by mulching. When artificial manures are expensive the fullest use should be made of cattle manure if it is available.

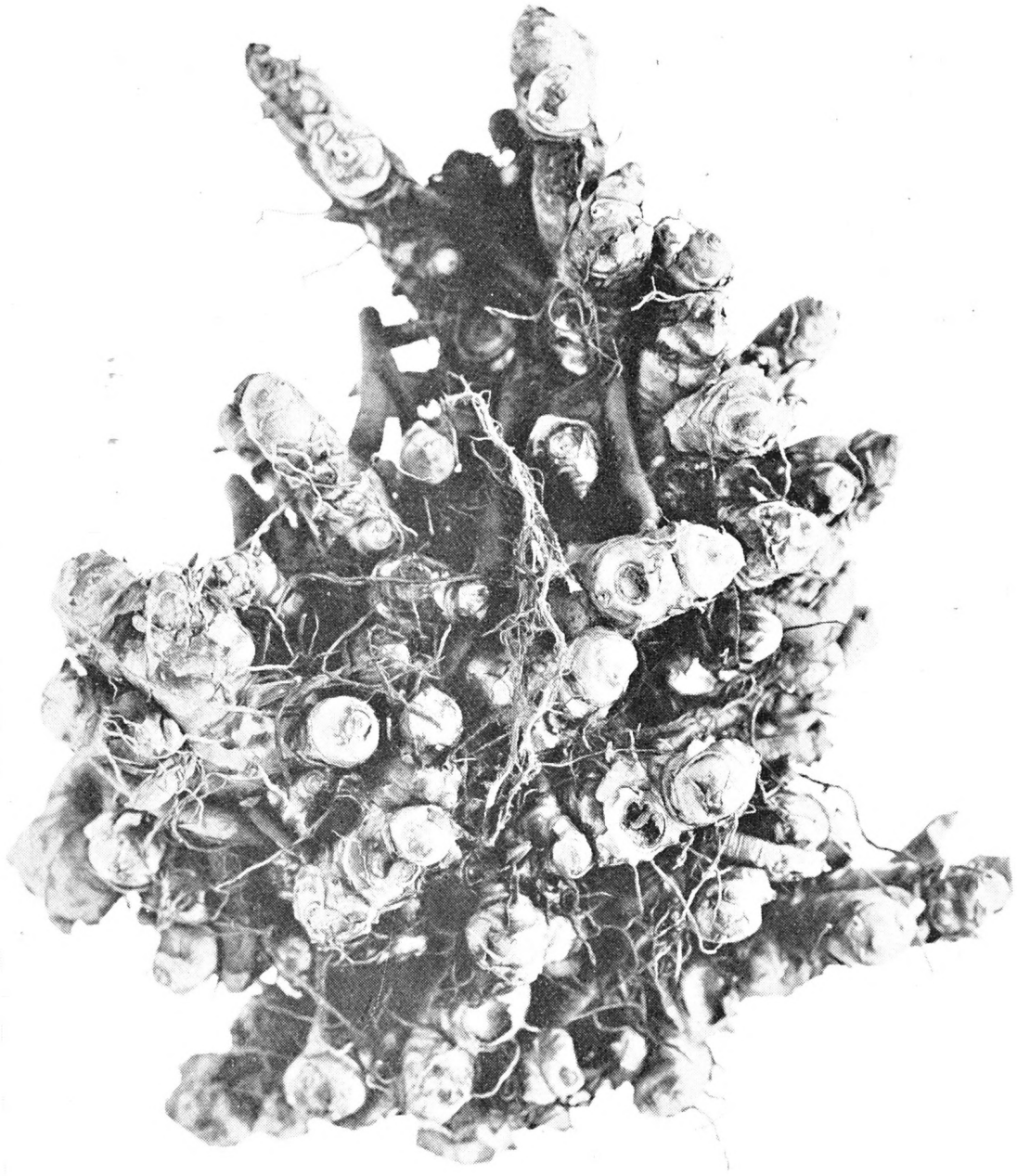
### SEED RATE EXPERIMENT

In order to determine to what extent the seed rate affected yields of ginger, a simple experiment was laid out in the form of a Latin Square. The ginger was intended to be planted out at the rates of one ton, half ton and one-third ton per acre of seed ginger, the local variety being used for the purpose; but the actual quantities applied worked out at one ton, .56 tons and .33 tons respectively. The size of each plot was 80 square feet, the number of holes per plot being 50. The holes were heavily manured with cattle manure as in the local method of planting. The yields per plot are shown in the plan below to the nearest lb. of green ginger.

	Columns			Total	Mean
	B 30	A 43	C 28	101	33.7
Rows	C 27	B 34	A 47	108	36.0
	A 45	C 26	B 31	102	34.0
Total	102	103	106	311	
Mean	34.0	34.3	35.3	General Mean	34.6

The treatment totals and means are as follows:

	Seed rate	Total lb.	lb. per plot
A	1 ton/acre	135	45.0
B	.56 "	95	31.7
C	.33 "	81	27.0



*L. S. Bertus*

*Photo.*  
Plate IV. Typical bunched ginger obtained in the local planting method

The statistical analysis of the data shows that the effect of treatment is clearly significant. The results are expressed in cwt. per acre and as multiples of the seed rate in Table X.

TABLE X

Seed rate	lb. per plot	Cwt./acre	Tons/acre	Fold
1 ton per acre	45	219	10.95	10.9
.56	31.7	154	7.7	13.8
.33	27	131.3	6.56	19.7

It will be observed that the seed rate of one ton per acre has given the highest yield return and the seed rate of .33 tons the lowest yield. Expressed in terms of the seed rate the yields however show an increase with decreasing seed rate. Thus the yield return from one ton per acre is about 11 fold, while that from .33 tons per acre is nearly 20 fold. The nett returns are however greater with the higher seed rates and it would appear therefore that from the practical standpoint the higher seed rates are preferable. A further investigation is however necessary to confirm these observations and experiments to this end have been started this season. One further point about this seed rate trial needs mention. The yields obtained, compared with those of the manurial trials, are appreciably higher. The high yields can be attributed to the very favourable situation of the plots and their good soil condition and are yet another instance of the effect of soil conditions on yield of ginger.

#### EXPERIMENT TO DETERMINE THE BEST METHOD OF PLANTING SEED GINGER FOR CURING PURPOSES

Another simple experiment to determine whether the planting of seed ginger in large hands (approximately 3 inches by 5 inches) as practised locally, is preferable to planting in small pieces as in Jamaica, from the standpoint of both yield and type of rhizome, was carried out in four randomised blocks each containing a pair of plots. Selected local ginger was planted in holes manured with cattle manure at a distance apart of 15 in. by 15 in., there being 60 holes to each plot. The plots and blocks were separated from one another by narrow drains. The seed rate worked out at about 2,722 lb. per acre.

The results are shown in Table XI below and typical hands from the two sets of plots shown in Plates IV and V for comparison.

TABLE XI

Blocks	Local Method lb. per plot	Jamaica Method lb. per plot
1.	46.5	44.5
2.	43.5	42.5
3.	37.5	34.5
4	32.0	29.0
Total	159.5	150.5
Mean	39.9	37.6
Difference		2.3
<b>Significant difference (P = .01)</b>		<b>8.1</b>

A statistical examination of the data shows that the average yield difference is definitely not significant for a probability of 100 to 1, though it amounts to about 10 cwt. per acre. The types of hands obtained appear however to be different. In the case of the Ceylon method of planting, the hands from a single set are small in size and, though numerous, bunched together. The 'fingers' too are very numerous. These characteristics are disadvantageous for curing. The hands from the small sets as in the Jamaica method appear on the other hand to be larger in size, are much less bunched together and separate quite easily. They are decidedly superior to the bunched hands for curing. It is likely however that even better ginger for curing purposes might be obtained by planting small sets with not more than two 'eyes' to a set, in holes at closer planting distances than those adopted in these trials. The point is being investigated by the Economic Botanist this season.

#### SUMMARY

Manurial, varietal, and cultural trials carried out with ginger at Giragama, the centre of a ginger growing area, during 1933, have indicated that under the soil and climatic conditions of the district:

(1) The local variety is a significantly better yielder than the Nugegoda variety (a type of degenerated Cochin ginger mixed with Calicut ginger).

(2) Manuring with artificials at the rate of 5 cwt. per acre is equivalent to manuring with cattle manure at 9.2 tons per acre. Both types of manuring give significantly higher yields than non-manured ginger.



*L. S. Bertus*

*Photo.* Plate V. Typical hands obtained by planting ginger in small sets

(3) A straw mulch produces a significant increase in yield.

(4) Liming is no advantage from the standpoint of yield.

(5) With raw ginger at Rs. 2/- per cwt., an increased profit of about Rs. 20/- per acre can be obtained by manuring and mulching or by mulching alone.

(6) Average yields of ginger vary appreciably with the soil type.

(7) The optimum seed rate for ginger, so far as these trials show, is about a ton per acre. The proportional yield increase is however greater with decreasing seed rate.

(8) If ginger curing is the object in view, the planting of ginger in small sets would appear to be preferable to planting in large hands as is done locally.

#### ACKNOWLEDGMENTS

Acknowledgment is made to Mr. W. Molegode, Senior Agricultural Instructor, Katugastota for the great care and attention with which he carried out the field work connected with these trials. Thanks are also due to Mr. L. S. Bertus for having taken the photographs accompanying the paper, to Mr. A. Geo. Alwis for having drawn Plate III, and to Mr. C. Canagaratnam, Agricultural Instructor, Headquarters for having assisted in the weighing of the ginger at harvesting.