MANURIAL TRIALS IN THE LOW COUNTRY

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Since 1956 two comprehensive manurial trials have been carried out by the Institute on low-country estates with high annual precipitations to ascertain the responses to plant nutrients applied, individually and collectively, at different levels to both seedling and vegetatively-propagated tea under these conditions.

Endane Trials

The first experiment was started on Endane Estate, Kahawatte, in January, 1956 in an area of seedling tea, about 35 years old, on good loamy soil containing relatively high percentages of organic matter and nitrogen. The average annual rainfall is about 125 inches, most of which falls in the South-West Monsoon. The pruning cycle on this estate is of 18 month duration. This has been adopted because of the high incidence of shot-hole borer which was observed to do most damage after this period. The trial was laid out in two different sections of the field. In each section there were three blocks of 27 plots, making a total of 162 plots in all. The size of each plot was 1/20th acre. Within each block the treatment-combinations were allocated at random.

In the first experiment (January, 1956 to April, 1957) only the effects of nitrogen and potash at each of three levels were [illegible] respectively 80, 120 and 160 poun[illegible] per acre per annum. The number [illegible] e. There were no yield differen[illegible] cycle. In the second cycle (April, [illegible] 1958) magnesium treatments were introduced at the three levels of 0, 30 and 60 pounds of magnesia per acre applied as magnesium sulphate. Again there were no significant differences between treatments. The same result was obtained in the third cycle (October, 1958 to May, 1960).

In the fourth cycle (May, 1960 to November, 1961) the treatments were varied, the nitrogen levels being reduced to 0, 40 and 80 pounds, potash to 40, 60 and 80 pounds, and magnesia to 0, 20 and 40 pounds per acre per annum. Once again there were no significant differences in yield between treatments. This was most surprising, considering that one set of nitrogen treatments was at the zero level.

Two of the reasons assigned for the non-response of the tea to manurial treatments were:

(1) the relatively high fertility of the soil. The Chemist found that soils from plots which had received no nitrogen for a year contained as high amounts of ammonia and nitrate as those which were manured with nitrogen, and (2) the good stands of the leguminous green manure trees Gliricidia, dadap and Albizzia moluccana in the plots. It was considered likely that both the trees themselves and their loppings, which amount to about 5 tons per acre per annum, arrested a rapid decline of yields which might otherwise have occurred earlier. There were indications, however, that the yields from the zero nitrogen plots were falling steadily towards the end of the cycle.

In order, therefore, to ascertain whether a prolongation of the trial would show a significant reduction in yield in these no-nitrogen plots, it was decided to maintain

the same levels of treatments in the fifth cycle as well. In this cycle (November, 1961 to November, 1963), however, the scope of the experiment was extended to include varying phosphoric acid treatments as well as spraying with dieldrex for the control of shot-hole borer, and with zinc sulphate, as some of the plots showed deficiency symptoms of this minor element. In order to test the effects of the latter treatments, one of the blocks in each section of the experimental area was sprayed with dieldrex at 6 pints in 10 gallons of water per acre by mistblower. Another pair was sprayed with zinc sulphate at varied concentrations, 4 times in the first and 5 times in the second year of the cycle, the total application of the chemical over the period being 37 lb per acre. The remaining blocks were left as controls. The field results of this cycle are set out in Tables IA &IB.

TABLE IA

ENDANE MANURIAL EXPERIMENT - 5TH CYCLE (1961-63)

YIELD OF CROP (lb. MADE TEA/ACRE)

SUB-TREATMENTS lb./ACRE/ANNUM		1ST SIX MONTHS		2ND SIX MONTHS		3RD SIX MONTHS		4TH SIX MONTHS		TOTAL ACRE/ANNUM	
		lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
	0	167	100	821	100	796	100	714	100	1249	100
N	40	163	98	840	102	818	103	831	116	1326	106
	80	160	96	839	102	869	109	866	121	1367	109
	20	166	100	831	100	810	100	822	100	1314	100
P_2O_5	40	163	98	842	101	837	103	792	96	1317	100
	60	161	97	827	99	836	103	798	97	1311	100
	40	163	100	832	100	827	100	774	100	1298	100
K_2O	60	166	102	836	100	824	100	833	108	1330	102
	80	161	99	833	100	832	101	803	104	1314	101
	0	162	100	828	100	828	100	809	100	1314	100
Mg	20	165	101	838	101	814	98	807	100	1312	100
	40	164	101	835	101	840	101	795	98	1317	100
AVERAGE		164		833		827		804		1314	
SIGNIFICANT DIFFERENCE AT P=0·05										44	3·5

TREATMENTS SHOWING SIGNIFICANTLY HIGHER YIELDS ARE UNDERLINED

TABLE I B

ENDANE MANURIAL EXPERIMENT - 5TH CYCLE (1961-63)

SEEDLING TEA

YIELD OF CROP (lb. MADE TEA/ACRE)

MAIN TREATMENTS	1ST SIX MONTHS		2ND SIX MONTHS		3RD SIX MONTHS		4TH SIX MONTHS		TOTAL ACRE/ANNUM	
	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
CONTROL	163	100	830	100	821	100	626	100	1220	100
ZINC SULPHATE	171	105	850	102	745	91	813	130	1290	106
DIELDREX	157	96	820	99	916	112	973	155	<u>1433</u>	117
SIGNIFICANT DIFFERENCE AT P = 0·05									128	10

TREATMENT SHOWING SIGNIFICANTLY HIGHER YIELD IS UNDERLINED

An examination of the data will show that at the end of the first year there were again no responses to any of the treatments. Differences, however, began to be apparent in the third six-month period. Accordingly, the cycle duration was extended to two years, and the number of fertilizer applications increased to 7 during this cycle. As anticipated, it was in the fourth six-month period that the effects of the treatments became most marked. This was particularly so in the case of the dieldrex and nitrogen treatments. The zinc sulphate blocks too showed an appreciable increase over the control at this stage. It would appear, therefore, that one reason why significant yield differences between treatments were not obtained in the earlier cycles of the trial was because the bushes were pruned at a stage when the benefits from the fertilizer applications had not been fully reaped. The extension of the cycle to 2 years provided for the more efficient utilization of the fertilizers applied.

TABLE II

ENDANE MANURIAL EXPERIMENT - 5 TH CYCLE (1961 - 63)

INTERACTION BETWEEN NITROGEN & DIELDREX

(YIELD lb/ACRE/ANNUM)

	NO NITROGEN	NITROGEN	DIFFERENCE
NO DIELDREX	1213	1277	64
DIELDREX	1333	1482	149
DIFFERENCE	120	205	85
SIGNIFICANT DIFFERENCE AT P=0.05			30

The statistical analysis of the cycle yield data shown in the foregoing tables and in Table II above leads to the following conclusions:

(i) The effect of nitrogen is significant at both the 40 and 80 lb per acre levels, the average yield increase being of the order of 80 lb or 6 per cent per acre per annum at the lower, and 120 lb or 9 per cent at the higher level. The increases are significantly linear though this may not be apparent from a cursory glance at the data. The net average nitrogen response is, however, only about 1.5 lb of crop per pound of nitrogen applied. This is comparatively low, but considering that this is the first occasion in 8 years when a response was obtained in this experiment, it is not unsatisfactory.

Attention should be drawn to the fact that though no nitrogen was applied to the tea in the control plots over the past two cycles lasting $3\frac{1}{2}$ years, the crop yield has averaged about 1,220 lbs per acre per annum during the period. Some reasons for this unexpected finding have already been discussed. One other may possibly be the leaching of fertilizers from plots higher up the slope to those lower down as appears to be the case on a trial at Palmgarden estate. It will be interesting to see, however, how long these yields could be maintained without manuring.

(ii) The response to dieldrex spraying has been significantly appreciable, the average overall crop increase being 17 per cent or about 210 lb per acre per annum over the control. Spraying with zinc sulphate has not increased yield significantly over the cycle, but there are indications that this treatment has been beneficial when it has been systematically given and that it may possibly reach the significant level in the next cycle when the zinc treatment will be applied on a more regular programme than previously.

(iii) There is a significant interaction between nitrogen and dieldrex spraying. Nitrogen has given a significantly higher yield increase in the dieldrex-treated blocks than in the non-dieldrex-treated blocks, the actual interaction amounting to no less than 85 lb per acre per annum. Where dieldrex was sprayed on nitrogen-treated plots, the average difference in yield was 205 lb per acre, whereas on plots without nitrogen the average increase was only 120 lb per acre.

(iv) There were no significant differences in crop yields between the various levels of potash, phosphoric acid and magnesia.

(v) There is good reason to justify the extension of the pruning cycle at Endane and in the low-country generally to two years, particularly if spraying with dieldrex against shot-hole borer is done.

Palmgarden Trials

Manurial trials on vegetatively-propagated tea were started in June, 1960 on Palmgarden Estate, Ratnapura, on a five-acre block of four-year old TRI 2023 clonal tea containing a good stand of Gliricidia and Albizzia moluccana green manure and shade trees. These were lopped about three times each year and the loppings, weighing about 6 tons per acre per annum, were used as mulch on the plots. The area is almost entirely free of blister blight and shot-hole borer.

For a year before the experiment started the yields of the experimental plots were recorded regularly. At the end of May, 1961 the plots were pruned and the treatments imposed thereafter. The object of the experiment was to determine the effects of all combinations of three levels each of nitrogen, potash and magnesia. Each of these combinations was applied in frequencies varying from 5 to 9 times in a cycle of 2 years. Phosphoric acid was maintained constant at the rate of 60 pounds per acre per annum. The design of the experiment, which was suggested by Dr Pearce, Statistician of the East Malling Research Station, was a 3^4 factorial with some of the higher order interactions confounded. The 81 experimental plots were laid out in 9 blocks of 9 plots each, the plots in a block being, as far as possible, on the same contour and of about the same yield potential. Plate I shows the terrain

PLATE I

of the experimental area. The details of the fertilizer treatments are shown in column 1 of Table III below. The fertilizers were applied by broadcasting between the contour rows of tea. Crop yields per acre per annum to the end of June, 1963, when the two year cycle was completed, are shown in column 2 of the table and the percentages in column 3. The significant differences are indicated at the bottom of the table.

TABLE III

PALMGARDEN MANURIAL EXPERIMENT (1961-63)

CLONE 2023

	lb/AC/ANNUM	YIELD OF MADE TEA LB/AC/ANNUM	%
NITROGEN	75	3124	100
	150	3340	107
	225	3448	110
POTASH	50	3290	100
	100	3360	102
	150	3264	99
MAGNESIA	0	3301	100
	24	3331	101
	48	3282	99
FREQUENCY OF APPLICATION PER CYCLE (TIMES)	5	3232	100
	7	3287	102
	9	3392	105
SIGNIFICANT DIFFERENCE AT P = 0.05		104	3

Treatments showing significantly higher yields are underlined

It will be observed from this table that:

(i) Only nitrogen, of the fertilizers applied, has given a significant increase in yield during the first cycle, the average response being 216 lb per acre or 7 per cent at the mid level (150 lb/acre/annum) and 324 lb or 10 per cent at the highest level of nitrogen (225 lb/acre/annum) over the lowest (75 lb/acre/annum). The statistical analysis of the data reveals that the response within this range of nitrogen is significantly linear—though this may not appear to be so—and equivalent to about 2.2 pounds of crop, on the average, for every pound of nitrogen applied. Figure I shows the regression line of the yield of crop on nitrogen application per acre. It follows therefore that responses to nitrogen at levels higher than 225 lb/acre/annum—the maximum applied in this trial—may possibly be expected under these soil and climatic conditions. But that a crop of about 3100 lb of made tea per acre per annum can be obtained from young V.P. tea on an application of only 75 lb of nitrogen per acre per annum is indeed remarkable, especially as the soil is not a rich one. For how long this yield will remain at this level of manuring has yet to be seen.

FIGURE I

EFFECT OF LEVELS OF NITROGEN

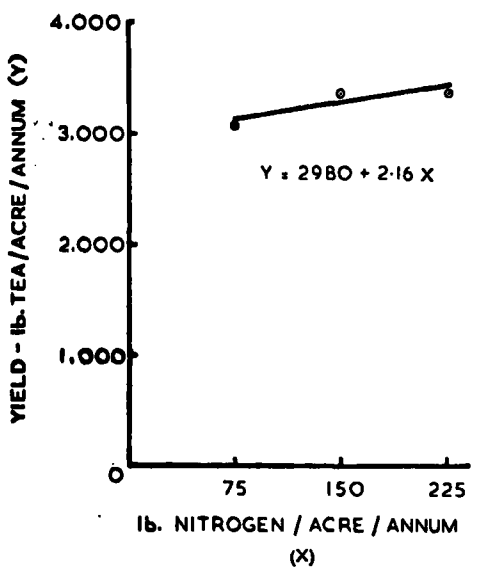
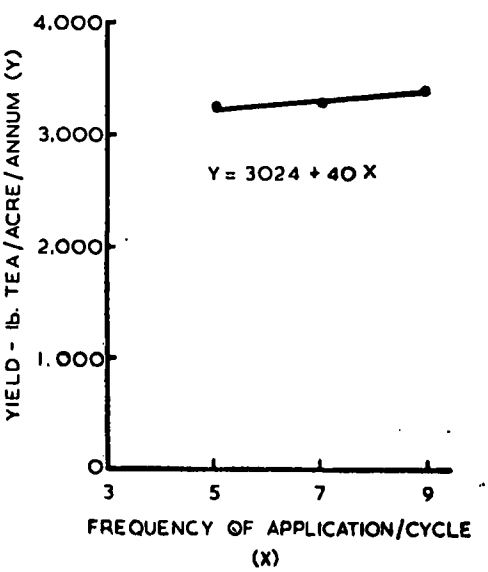


FIGURE II

EFFECT OF FREQUENCIES OF APPLICATION



(ii) In regard to the frequency of application of fertilizer, the yield data indicate that 9 applications per cycle are significantly better, on the average, than 7 and 5 applications respectively. Figure II shows the regression of yield on frequency of application. On the average, an extra 40 pounds of crop per acre were obtained for every additional application given, the total amount of fertilizer being kept constant. It will be seen, however, from Table IV overleaf that there is a progressive increase in yield as the frequency-fertilizer level combinations rise and that the beneficial effect of nitrogen is greatest at the highest frequency and level of application.

TABLE IV

MANURIAL EXPERIMENT - PALMGARDEN (1961-63)

COMBINATION OF NITROGEN (N) /ACRE/ANNUM & FREQUENCY OF APPLICATION (F) PER CYCLE	YIELD OF MADE TEA lb./ACRE/ANNUM	%
N_{75} F_5	3066	100
N_{75} F_7	3072	100
N_{75} F_9	3238	105
N_{150} F_5	3318	108
N_{150} F_7	3346	109
N_{150} F_9	3346	109
N_{225} F_5	3306	108
N_{225} F_7	3443	112
N_{225} F_9	3596	117
SIGNIFICANT DIFFERENCE AT P= 0·05	200	6

Table V records the average yields of crop per acre for each successive period of 6 months during the 2 year cycle. The yield of crop obtained in the last six months of the cycle was as high as 2,300 pounds per acre.

TABLE V

PALMGARDEN TRIAL

MEAN YIELDS OF CROP FOR SUCCESSIVE 6-MONTH PERIODS

	AVERAGE YIELD/ACRE lb.
1 ST SIX MONTHS	526
2 ND SIX MONTHS	1542
3 RD SIX MONTHS	2252
4 TH SIX MONTHS	2297

Discussion

It would appear, therefore, that vegetatively-propagated tea, under conditions obtaining at Palmgarden Estate, could probably have its pruning cycle extended by at least a further period of six months, provided limiting factors such as height of bush were not operative. This trial is being continued at the same fertilizer levels but with frequency of application increased to 7, 9 and 11 per cycle. Even more interesting results than those outlined might emerge. But it is satisfactory to note that under the heavy rainfall conditions obtaining at Palmgarden—the average annual precipitation being about 160 inches per annum—and on a soil which is very gravelly in sections, the more frequent the application at the highest level of fertilizer applied, the better is the response to be expected.

Summary and Conclusions

The results of manurial trials carried out since 1956 on two low-country estates—at Endane Estate, Kahawatta with seedling tea and at Palmgarden Estate, Ratnapura on V.P. tea—are surveyed. On the former no response to any nutrient was obtained, though the levels were varied, until the fifth cycle and that only in respect of nitrogen and when the cycle duration, which was 18 months, was extended to two years. The effect of dieldrin spraying for the control of shot-hole borer was also

statistically significant in this cycle, particularly so during the fourth six-month period by which the cycle was extended. The effect of nitrogen was marked in the dieldrin-sprayed blocks and the interaction between the two factors was significant. The extension of the cycle duration to two years on this estate and, in the low-country generally, appears to be indicated particularly where spraying with dieldrin against shot-hole borer is adopted.

In the Palmgarden V.P. trial, of two years' cycle duration, nitrogen gave statistically significant linear yield increases from 75 to 225 lb/acre per annum, the increase between these levels being of the order of 10 per cent or approximately 325 lb per acre per annum. The frequency of application of fertilizers was also significant, the greatest yield increase (of the order of 17 per cent) being obtained at the highest frequency (9 times per cycle) and level of application. A very appreciable proportion of the crop is obtained during the last quarter of the cycle, and the extension of the latter to 2½ years is indicated where limiting factors such as height of bush do not operate.

Acknowledgments

In concluding this brief review of the experiments carried out at Endane and Palmagarden Estates, I have to express our thanks to the management of these estates for the facilities offered us by them for conducting these experiments and for the ready co-operation they have always extended to us. I am also obliged to Mr P. Kanapathipillai, our Statistician, for having carried out the statistical analyses of the recent data of these trials and to Dr L. H. Fernando, Low Country Scientific Officer, for having supervised these trials on my behalf from January, 1963 until the completion of their respective cycles. To Mr J. A. H. Tolhurst, our Chemist, I am indebted for assistance during the course of the experiments, and to Mr J. E. Cranham, Entomologist, for advice on and collaboration in the shot-hole borer control investigation in the Endane trial.