TOBACCO INVESTIGATIONS IN THE GAL OYA VALLEY

S. Kandiah and K. Ratnasingham

(Ceylon Institute of Scientific and Industrial Research)

Tobacco being a cash crop, its cultivation in the Gal Oya Valley on lowlands, in rotation with paddy during the Yala (dry) season and on highlands where water by lift irrigation could be made available, is engaging the attention of the Gal Oya Development Board of Ceylon. Investigations were therefore undertaken with the object of (1) ascertaining the cause for the yellowing and premature ripening of tobacco with consequent low yields, (2) recommending fertilizer mixtures suitable for the various types of soils found in the Valley, (3) improving the quality of the final product. The results obtained are discussed.

CHLOROSIS, PREMATURE RIPENING AND LOW YIELDS

A number of fields where the crop was chlorotic and ripening prematurely with consequent low yields was investigated. In every case, one soil pit where the crop was yellowing and another one where the crop was healthy for comparison, as far as possible in its vicinity, were opened up and the profiles examined. In the case of diseased conditions, the soil, a few inches below the surface, was in every instance of a grey blue or dark blue colour indicating the presence of ferrous iron. No such colouration could be seen in soils with healthy crops. Soil samples from three such sets were collected for the determination of ferrous iron and an assay of their play nutrient status. The results of ferrous iron determination shown in Table I would provide unmistakable evidence of a high concentration of ferrous iron even in the top six-inch layer of soil where the plants were diseased.

While only mere traces of ferrous iron could be detected under healthy conditions, amounts varying from about 800 to 1,000 p.p.m. were found to be present in soils carrying diseased crops. An examination of the root system of the diseased plants indicated that most of the main roots were dying from the tips and the plants were struggling to live by putting forth fresh adventitious roots around their collars. Further evidence was sought by analysing samples of leaves of about the same physiological age collected from healthy and diseased plants and by comparing the results of analysis of the soils and of the plant materials. The results of soil analysis are given in Table II. These do not bring out anything striking beyond the slightly higher concentration of nitrates in the soil under the diseased crop than in others and the very low calcium status of all soils. The leaf analysis on the other hand reveals some interesting features as could be seen from Table III.

An examination of the data in Table III would indicate that with the single exception of phosphoric acid, the concentration of all other major nutrients is far higher in the leaf of the healthy plant than that of the diseased. This would show that the diseased plants, because of the defective root system, do not absorb the nutrients available in the soil.

Why the content of phosphoric acid alone should be more in the diseased plants needs elucidation. Two possible explanations can be given. Various investigators have shown that most plants absorb phosphoric acid in their early stages and that they could even be starved of it later, if they have had an abundant supply in the early stages. The diseased plants themselves grow well in the early stages, presumably till the roots reached the layer of ferrous iron concentration, which began to exert its toxic effect on the plants and even killed some. As the diseased plants, unlike the healthy ones, failed to put on fresh weight the phosphates absorbed in the early stages had evidently helped to maintain a higher percentage in the leaf. The other explanation is bound up with the availability of phosphates in these soils. The reaction of the tobacco soils being acidic, pH 5.8—6.0, phosphates would combine largely with the soil iron forming phosphates. In soils carrying the healthy plants, however, the phosphates are in the form of insoluble ferric phosphates, while in the soils under diseased plants ferrous iron concentration is high and the phosphates appear mainly as soluble ferrous phosphates, which the plants readily take up. This is evidently reflected in a higher percentage in the leaf.

FORMATION OF FERROUS IRON

It becomes necessary therefore to explain the reason for the high concentration of ferrous iron in the soil. Iron is only second to aluminium in abundance in soil, but under normal conditions it exists in the almost inert ferric form. When, however, the soil becomes subject to prolonged waterlogging, anaerobic conditions prevail and ferric iron is reduced to the ferrous form, which is soluble and proves toxic to plants beyond certain narrow limits. The chlorotic condition and premature ripening of tobacco are thus brought about by the toxicity of excessive ferrous iron, as shown by the soil analysis.

PREVENTION OF REDUCTION TO FERROUS FORM

Tobacco is mostly grown on paddy lands in rotation with paddy, cultivated, as is well known, under water-logged conditions immensely favourable for the reduction of ferric iron to ferrous form. This reaction is reversible and when well aerated conditions in the soil set in on drying the ferrous form is reconverted more readily, into the ferric form. What is necessary, therefore, is in the first instance, to plough the land that is to be brought under tobacco, immediately after harvesting the paddy so as to encourage the oxidation of the ferrous to the ferric form. Water-logging thereafter should be prevented by promoting soil drainage. This is best effected by opening the land into a series of ridges and furrows and by growing the crop on the ridges.

In the circumstances under which tobacco is cultivated in the Valley one cannot be too certain of preventing, at least in certain allotments, ill-drained conditions being created, owing to the fact that tobacco is cultivated in small plots surrounded on all sides by paddy. The conditions would however change if tobacco is cultivated over fairly extensive tracts.

MODIFICATION IN THE SYSTEM OF IRRIGATION

The present system of irrigation, it would appear, is to issue large quantities of water at long intervals, in the belief that it would induce a deeper root system of the plants. Such a procedure will no doubt be of great advantage in areas where the crop is grown under rain-fed conditions or where the crop has to fend for itself, as far as plant nutrients are concerned. Where irrigation is practised and the crop is heavily fertilized this may not be very necessary. Under the conditions obtaining in most of the paddy areas in the Valley this practice however becomes positively harmful as it would induce water-logging and consequent increase in ferrous iron. It is the common experience to see a crop growing quite luxuriantly during its early stages suddenly becoming sickly and chlorotic. This has been shown to be due to the root system extending deeper and coming in contact with the layer of soil rich in toxic ferrous iron.

Lighter irrigation will therefore be beneficial but most of the tobacco soils are sandy and the plants may suffer from want of water in the seedling stage unless irrigations are frequent. For the same reason it is disadvantageous to have too high ridges to begin with. The ridges on sandy soils, at the start, should be low and these should be gradually raised with consequent deepening of the furrows as the plants grow. On the sandy high lands it does not appear necessary to have raised ridges any time as such lands are not subject to water-logging. On the other hand the plants in such soils, especially in the seedling stage, may suffer from want of moisture. The very high casualty rate observed in the seedling stage on some sandy soils was partly at least due to insufficiency of moisture at that stage. Shallow drains to take away flood waters during heavy rains should suffice and the absolute necessity to have the drains properly graded need hardly be stressed. Suitable measures for protection against heavy blowing should be devised.

FERTILIZER TRIALS WITH TOBACCO

The aim in cultivation is directed mainly towards securing the maximum possible yields, but in the case of tobacco quality of the final product is far more important than quantity. Fertilizer recommendations for tobacco are therefore difficult to make until the quality and yield of the crop is studied by conducting manurial trials on different types of soil.

One set of fertilizer trials was accordingly carried out on cultivators' lands and another on the Model Farm in Unit 4. On cultivators fields, three fertilizer mixtures of varying N : P : K ratios were tried out on the sandy loam type of soils, while on the loamy soils in the Model Farm six mixtures containing N. P. K. at different levels were tested.

Representative samples of fresh leaves from each one of these trials were cured separately to study the effect of fertilizer on the quality of the cured product. The composition of the fertilizer mixtures, the yield of green leaf per plant, the price per pound of green leaf, the percentage of dry matter and the price per pound of cured leaf are put down in Table IV. On a basis of 6,200 plants per acre the total yield is ascertained. The total amount of cured leaf is worked out from the percentage of dry matter. The price per pound serves as an index of quality of the product and the price per pound of green leaf multiplied by the total yield gives the income per acre the cultivator gets.

An examination of the data given in Table IV would reveal that the yield of green leaf varies from a maximum of 8,804 lb. per acre in the case of allotment 119 in Unit 4 to as low as 1,965 lb. in allotment 97 of Unit 15. It would also be seen that the highest price of 17.2 cents per lb. of green leaf has been fetched by the latter allotment indicating thereby that the quality generally tends to improve when the yield is low. This is confirmed by the high prices fetched by the cured leaf where yields are generally low.

A comparison of the yield and the quality of the leaves from the plots treated with the three fertilizer mixtures B1, B2 and B3 would show that the average yields per plant are 0.799, 0.855 and 0.853 per lb. respectively, and the corresponding prices are 14.8, 14.7 and 15.2 cents per lb. The percentages of dry matter amount to 14.7, 14.4 and 16.3 respectively and the corresponding prices for the cured products are Rs. 2.55, 2.67 and 2.61. A calculation of the value of the cured products gives Rs. 1,856, Rs. 2,037 and Rs. 2,249 per acre, while in the green stage they fetch Rs. 734, Rs. 780 and Rs. 804 respectively. The difference between any two treatments does not attain statistical significance but judging by the price per pound either in the green stage or after curing, treatment three would seem to be superior to the rest.

FERTILIZER TRIAL IN MODEL FARM—UNIT 4

The soils of the farm are loamy and the six fertilizer mixtures, details of which are given in Table V, were tried out in four replications on a randomised basis. Omitting the details, a summary of the yield of green leaf per plant, its price per pound, the percentage of dry matter and the price per pound of cured leaf is only given.

An examination of the data in Table V would reveal that the yield of green leaf varies from 1.33 to 1.88 lb. per plant. Even the lowest value of 1.33 works out to the comparatively high yield of 8,200 pounds per acre while the high figure of 1.88 results in the phenominally high yield of 11,600 pounds. The highest price fetched is 13.7 cents and the lowest 12.4 cents per lb. A much larger variation, from 12.96 to 7.80 could be observed in the percentages of dry matter from the various treatments. The price of the cured product which serves as an index of quality is Rs. 1.51 in treatment 4 as against 0.95 cents in treatment 6. It will be seen that while the yields are generally high, the quality of the product has suffered to a large extent.

An analysis of the cured leaf would have helped to account for this low quality, but this has unfortunately not been done. Working out the total value of the crop in the green stage for each mixture would give the respective figures of Rs. 1,500, Rs. 1,023, Rs. 1,241, Rs. 1,562, Rs. 1,274 and Rs. 1,504 per acre. Of these it is clear that mixtúre 4 proves to be the best. There is hardly any difference between No. 1 and No. 6 as far as the total values are concerned, but the quality of No. 1 is definitely superior to that of No. 6. No. 2 fetches the lowest price.

It will be of interest to work out the N/P, N/K and P/K ratios of these fertilizer mixtures and to ascertain the relationship that exists between any particular set of ratios and the yield and quality of the crop. These ratios are given in Table VI.

It will be seen that in mixture No. 4, the one performing best, these ratios are 2.0 : 2.5 : 12.5. In mixture No. 1, the second best, potash is a bit too high, as could be seen from the low P/K and N/K ratios and it should be reduced to bring it into conformity with No. 4. In No. 6, the potash should still further be reduced. In No. 2, the worst, nitrogen is in excess.

A very interesting fact is brought out when the N/P, N/K and P/K ratios of 2.5 : 3.1 : 12.5, those found to be the most suitable for sandy loams, are compared with the 2.0 : 2.5 : 12.5 ratios found best on the loamy soils at the Model Farm in Unit 4. When the former is reduced to the common base of 2.0, these would work out to 2.0 : 2.5 : 10. It will be seen that the N/P and N/K ratios are identically the same. The P/K ratio is low, due to the higher potash content in the mixture to make up the deficiency in the sandy loams.

STUDIES ON QUALITY

The Tobacco Growers' Society organised by the cultivators in Unit 8, where records of green leaf and of the cured product are maintained separately for each member, afforded a valuable opportunity to study the correlation existing between the quality of the leaf and its composition as determined by chemical analysis.

Samples of cured products of grade I and of the lower grades of tobacco grown on highlands and on paddy fields, were analysed for nitrogen, ash, phosphoric acid, potash, lime and magnesia. The results so as to make them comparable are all expressed on a moisture-free basis. The percentage values for the various mineral constituents expressed as such do not bring out the finer points in the composition. It was therefore considered better to calculate and to express each of these constituents as a percentage of the ash rather than on the original material. With a view to bringing out the finer points still more clearly, the ratio one mineral bears to another was worked out and included in the Tables.

In Table VII are given the results of analysis of the samples of tobacco grown on highlands. A study of the data would indicate that of the mineral elements, the high grade tobacco contains a higher percentage of phosphorus and of potassium with a lower percentage of calcium and of magnesium than the lower grades. The average phosphorus content in the former is 3.64 per cent. as against 2.51 per cent. in the latter. The potassium, calcium and magnesium figures are 24.2, 12.1 and 3.51 per cent. respectively for grade I while the corresponding values for the lower grade are 22.4, 12.7 and 4.43 percent. As regards nitrogen, the lower grades are richer in this constituent corresponding values for the lower grade are 22.4, 12.7 and 4.43 per cent. Though calcium and magnesium are found in excess in the low grade leaves, an examination of the ratios would reveal that excess in the case of magnesium is much greater than that of calcium, as could be seen from the Ca/Mg ratios for the low grades. This observation receives confirmation from the high Mg/P ratio and the low K/Mg ratios found in these cases.

PADDY LAND CROP

The results of analysis of four samples of grade I leaves and four samples of the lower grades are recorded in Table VIII.

Here again it will be noted that the low grade samples are richer in nitrogen, calcium and magnesium and lower in potassium and phosphorus than the grade I samples, the average pairs of values for the low and high grades being respectively 3.20 and 2.41 percent for nitrogen ; 15.2 and 12.3 percent for calcium, 4.46 and 3.36 percent for magnesium, while the corresponding values for phosphorus are 2.31 and 2.64 and for potassium 18.4 and 24.3.

DISCUSSION

A consideration of the studies on the quality of tobacco would indicate that there is a certain critical limit for each of these constituents, beyond or below which the quality of the product is affected. It is not presumed that these studies are sufficient enough to define precisely these limits, but they can be regarded as giving certain indications. Of the elements studied, nitrogen, calcium and magnesium seem to have a ceiling value beyond which they affect the quality adversely while potassium and phosphorus have minimum limits below which again the quality gets affected. As regards nitrogen the optimum value appears to be in the neighbourhood of 2.4 percent on a moisture-free basis. Of the mineral elements, though calcium and magnesium are objectionable, an excess of magnesium beyond certain limits appears to have a greater deleterious affect on quality than that of calcium, as far as tobacco in the Valley is concerned. It is of value to note that magnesium is an essential constituent of the chlorophyll and is considered very important in tobacco nutrition. In fact a deficiency in magnesium is known to produce the " sand-down " disease in tobacco and fertilizer mixtures normally supplying nitrogen, phosphoric acid and potash to tobacco are invariably fortified with the addition of a magnesium salt. In the Valley, however, soil analysis has indicated that these soils are generally very high in magnesium and so very low in calcium that the adverse effect is as much due to the excess of magnesium as to the low levels of calcium, thereby bringing down the calcium/magnesium ratio. The maximum limit for calcium seems to be roundabout 12.0 percent and for magnesium in the neighbourhood of 3.5 percent.

In the same manner any deficiency of phosphorus beyond the minimum limit seems to affect the quality more than that of potassium. Potassium is no doubt extremely important for cigarette tobacco as it promotes the burning quality more than any other constituent, but phosphorus is evidently the prime factor as far as quality of tobacco is concerned. The minimum value for potassium can be reckoned as being close to 24 percent and for phosphorus to 3.0 percent of the ash on a moisture-free basis.

COMPARISON OF MARGINAL AND MIDDLE PORTIONS OF AFFECTED LEAVES

The leaves from some tobacco plants grown in the Valley show certain peculiar symptoms in contrast to normal plants, particularly during the ripening stage. The leaves instead of assuming a uniform light lemon yellow colour on ripening show a mottling of dark yellow in the background of a green surface. These markings are predominant along the tip and margin of the leaf. Such leaves do not cure properly and turn dark brown and become very brittle. During subsequent handling the marginal portions and tips of the affected leaves tend to crumple down to dust while the middle portions remain intact. Samples of such affected leaves were collected from three centres, Uhana, Weeragoda and the Central Camp and the marginal and middle portions were gathered into two separate lots and were analysed to ascertain if any difference in the chemical composition would elucidate the reason for the peculiar condition observed. The results of analysis are set out in Table IX.

A comparison of the average values obtained from the data would bring out one special feature. It has been shown earlier that grade I leaves have high contents of phosphorus and of potassium but are low in nitrogen, calcium and magnesium and that the reverse is the case with the lower grades.

A comparison of the average values will however reveal that in this instance the middle sections, besides being richer in potassium and phosphorus, have also a higher magnesium content, or in other words, the marginal section while being very low in phosphoric acid and potash has a comparatively much higher calcium content. This is brought out far more clearly by the higher Ca/P and higher Ca/Mg ratios.

COMPARISON OF 'PAPERY' AND NORMAL LEAVES

Another peculiar feature noticeable in certain instances in the tobacco grown in the Valley is the lack of body in the leaf and this condition becomes strikingly noticeable after the leaf has been cured. The cured leaf is very thin, has no texture whatever and resembles a tissue paper, and the texture is aptly described as "papery". Four samples of such leaves collected from Unit 8 have been analysed to determine their chemical composition and to ascertain if any relationship could be detected between this condition of the leaf and any particular feature in its chemical composition in comparison with that of a normal leaf. The results of analysis are shown in Table X. The average values of grade I leaves detailed in Tables VII and VIII are included for purpose of comparison.

The results outlined above would seem to indicate that the papery leaf like any leaf of the lower grades contains more nitrogen, more calcium and more magnesium than grade I leaf but the striking feature in this case is the extraordinarily high content of magnesium in the papery leaves. Compared with grade I, the amount of magnesium is almost double in the ash of papery leaves, the actual percentage increase being 97·1. As opposed to this, the observed increase in magnesium in the low grade leaves over grade I is only 27.5 per cent., in the case of the highland crop and 23.5 per cent. in tobacco grown on paddy land. In contrast to this abnormal increase in magnesium, calcium in papery leaves exceeds that of grade I leaves only by about 34 per cent. As regards nitrogen the increase is about 45 per cent. Excessive magnesium would therefore seem to be the primary factor responsible for the lack of body and texture in the papery leaf.

COMPARISON OF PUCKERED AND NORMAL LEAVES

A third type of abnormality observed in the tobacco in the Valley is "puckering" of the leaves. The leaves of affected plants are very thick and coarse in texture and the leaf surface, due to a series of gentle dips and risings, presents an uneven appearance. This condition becomes more and more pronounced as the crop reaches the ripening stage. The leaf does not cure properly and turns dark brown in colour. Two samples of the affected leaves and for comparison two samples of normal leaves collected from plants close to each other were analysed and the results of analysis are put down in Table XI.

From these results it will be observed that here again the puckered leaves are comparatively richer in the three elements, nitrogen, calcium and magnesium and poorer in phosphorus and potassium than the normal leaves. While calcium is the predominant element in the brittle marginal section of the leaves and magnesium in the papery leaves, nitrogen is the element that is overwhelmingly high in puckered leaves. The excess of nitrogen registered over the normal is nearly 70 per cent. as compared to the increase of 13.6 per cent. of the low grades on highland and 32 per cent. of the low grades on paddy lands over grade I quality tobacco.

SUMMARY

A certain amount of information which should prove useful to the tobacco industry in the Valley has been obtained as a result of the investigations described above. It is however not claimed that the results are conclusive. They should be treated as giving some indications for improving the industry and stressing the need for further work in this direction.

The results obtained may be summarised as follows:—

(1) Paddy lands of small extents surrounded by cultivated paddy should as far as possible be eliminated from being cultivated with tobacco.

(2) Paddy lands to be cultivated with tobacco should be ploughed in soon after the paddy has been harvested and exposed.

(3) The ridges need not be high at the start, particularly on sandy soils, as the seedlings may suffer from want of moisture. They should be raised gradually with corresponding deepening of the furrows as the plants grow.

(4) Heavy irrigation should be avoided. Light but frequent irrigations are preferred.

(5) Suitable system of cultivation to be devised or artificial protection given against damage by blowing.

(6) A mixture containing N/P: N/K: P/K in the ratio of 2.5: 3.1: 12.5 appears to be the most suitable one for sandy loans and sandy soils, while one with these ratios at 2.0 : 2.5 : 12.5 seems best for loams and heavier types.

(7) As for quality, there seems to be a critical limit for each constituent below which certain elements and beyond which certain other elements begin to affect the quality adversely. These studies seem to indicate that the minimum limit for phosphorus is about 3.0 percent and for potassium about 24 percent, while the maximum amount for nitrogen should be round about 2.4 percent, for calcium 12.0 percent and magnesium 3.5 percent.

(8) Excessive calcium appears to be the factor connected with uneven ripening and brittleness in the leaf for curing.

(9) An unduely large percentage of magnesium seems to affect adversely the texture of the leaf and to make it "papery".

(10) Excessive nitrogen appears to make the leaf coarse in texture and to cause "puckering" in the leaf.

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TABLE I
Ferrous Iron in Soils
(on Moisture Free Basis)

No.	*Location*	*Condition of Crop*	*Ferrous Iron parts per million*
1 ..	Village 22 Allot. 133 ..	.. Good	.. Minute traces
2 ..	Village 22 Allot. 133 ..	.. Bad	.. 1094
3 ..	Village 23 Allot. 32 ..	.. Good	.. Nil
4 ..	Village 23 Allot. 32 ..	.. Bad	.. 802
5 ..	Village 27 Allot. 87 ..	.. Good	.. Traces
6 ..	Village 27 Allot. 87 ..	.. Bad	.. 865

TABLE II
Available Nutrient Status of Soils

No.	*Location*	*Condition of Crop*	*pH*	*Nitrates*	*Potash*	*Lime*	*Magnesia*	*Phosphoric Acid*
1	Vil. 22 Allot.133	..Good	..5.8	..V. low	..Med.	..V. L.	Low	..Low-med.
2	Vil. 22 Allot. 133	..Bad	..6.5	..Low	..Med.	..V. L.	High	..Med.
3	Vil. 23 Allot. 32	..Good	..6.6	..V. low	..Med.	..V. L.	High	..Med.
4	Vil. 23 Allot. 32	..Bad	..5.9	..Low	..Med.	..V. L.	High	..Med. High
5	Vil. 27 Allot. 37	..Good	..6.0	..V. low	..High/Low	V. L.	Med.	..Med.
6	Vil 27 Allot. 87	..Bad	..6.0	..Low	..Med.	..V. L.	Med. High	..Med.

TABLE III

Analysis of Tobacco Leaves—Healthy and Diseased

No.	Location	Condition of Crop	On Fresh Material: Moisture %	On Fresh Material: Dry Matter %	Ash %	Nitrogen %	On Moisture-Free Basis: Lime %	On Moisture-Free Basis: Potash %	On Moisture-Free Basis: Magnesia %	Phos. Acid %
1	Village 22 Allot.	133 Healthy	91·77	8·23	20·52	2·58	3·18	5·93	1·61	0·446
2	Village 22 Allot.	133 Diseased	86·68	13·32	16·82	1·53	1·54	5·25	0·782	0·539
3	Vilage 27 Allot.	87 Healthy	90·30	9·70	16·97	2·90	1·50	6·01	1·07	0·651
4	Village 27 Allot.	87 Diseased	87·42	12·58	13·00	0·904	1·20	4·57	0·547	0·680

TABLE IV

Fertilizer Trial on Cultivators Fields

	Fertilizer Mixtures					
	Quantities			*Ratios*		
	N	*P*	*K*	*N/P*	*N/K*	*P/K*
B 1	25	80	80	3·1	3·1	10·0
B 2	25	90	80	2·8	3·1	11·2
B 3	25	100	80	2·5	3·1	12·5

Unit/ Allotment No.	*Fertilizer Mixture*	*Green Wt. per plant in lbs.*	*Green Wt. per acre in lbs.*	*Price per lb. Green leaf cts.*	*Percentage dry matter*	*Price per lb. Cured Leaf Rs. c.*
3/1	B 1	0·976	6,050	13·2	19·2	2 26
	B 2	0·977	6,057	13·5	18·7	2 17
	B 3	0·992	6,152	13·4	15·2	2 39
4/119	B 1	1·32	8,185	12·3	11·20	2 80
	B 2	1·42	8,804	14·6	10·10	3 05
	B 3	1·32	8,185	13·6	10·80	2 81
15/97	B 1	0·317	1,965	16·9	21·6	2 85
	B 2	0·371	2,300	16·0	18·8	2 84
	B 3	0·448	2,777	17·2	16·2	2 99
5/84	B 1	0·378	2,343	14·9	8·5	2 59
	B 2	0·683	4,235	13·8	10·4	2 67
	B 3	0·473	2,933	15·5	25·0	2 87
6/70	B 1	1·28	7,936	14·7	14·4	2 39
	B 2	1·14	7,068	13·8	14·1	2 45
	B 3	1·32	8,185	15·5	17·0	2 17
11/20	B 1	0·523	3,243	16·7	13·4	2 43
	B 2	0·541	3,355	16·7	14·1	2 86
	B 3	0·567	3,576	16·3	13·6	2 46

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TABLE V

Fertilizer Trial on Model Farm—Until 4

Fertilizer Mixture	N	P	K
1	20	80	70
2	20	90	70
3	20	100	70
4	20	100	80
5	20	100	90
6	20	100	100

Fertilizer Mixture	*Green Wt. per plant in lb.*	*Price per lb. green leaf cts.*	*Percentage dry matter*	*Price per lb. Cured Leaf* *Rs. c.*	*Price of Green Leaf per acre.* *Rs.*
1	1·85	13·1	10·96	1·56	1,500
2	1·33	12·4	7·80	1·33	1,023
3	1·54	13·0	12·96	1·26	1,241
4	1·88	13·4	8·67	1·51	1,562
5	1·50	13·7	9·10	1·40	1,274
6	1·81	13·4	11·41	0·95	1,504

TABLE VI

Mixtures

	N	P	K	N/P	N/K	P/K
1	20	80	70	2·5	2·9	11·4
2	20	90	70	2·2	2·9	12·8
3	20	100	70	2·0	2·9	14·3
4	20	100	80	2·0	2·5	12·5
5	20	100	90	2·0	2·2	11·1
6	20	100	100	2·0	2·2	10·0

TABLE VII

Highland Crop

No. Unit/Allot, Grade	*On moisture-free basis*					*Percentage on ash*				*Ratios*					
	Nitrogen %	*Phosphoric Acid* %	*Potash* %	*Lime* %	*Magnesia* %	*Phosphorus*	*Potassium*	*Calcium*	*Magnesium*	*K/P*	*Ca/P*	*Mg/P*	*K/Ca*	*K/Mg*	*Ca/mg-*
1. 8/7 Grade I ..	2·21	0·681	3·23	2·31	0·697	2·39	21·1	13·0	3·44	9·0	5·5	1·4	0·22	2·1	2·3
2. 8/42 Grade III ..	2·56	0·564	3·32	1·70	0·679	2·24	25·6	11·1	3·88	11·1	5·0	1·7	1·0	1·8	1·7
3. 8/44 Grade I ..	1·96	0·813	3·36	1·66	0·552	3·44	26·2	11·4	3·27	6·0	2·6	0·74	0·94	3·6	2·1
4. 8/54 Grade II ..	2·63	0·950	2·86	1·99	0·826	3·57	20·9	12·2	4·27	5·7	3·4	1·2	0·86	1·8	2·1
5. 8/50 Grade I ..	2·88	0·740	3·85	2·09	0·802	5·10	25·2	11·8	3·81	5·0	2·3	0·74	1·1	2·1	1·9
6. 8/50 Grade V ..	2·81	0·504	3·20	2·65	1·11	1·71	20·6	14·7	5·15	9·5	8·6	30·0	0·72	1·2	1·7
Average of Grade I ..	2·35	0·745	3·48	2·02	0·684	3·64	24·2	12·1	3·51	6·7	3·3	0·96	1·1	2·2	2·1
Average of Other Grades	2·67	0·676	2·76	2·11	0·872	2·51	22·4	12·7	4·43	8·9	5·1	1·8	0·91	1·6	1·7

TABLE VIII

Paddy—Land Crop

No. Unit/Allot, Grade	On moisture-free basis					Percentage on ash				Ratios					
	Nitrogen %	*Phosphoric Acid* %	*Potash* %	*Lime* %	*Magnesia* %	*Phosphorus*	*Potassium*	*Calcium*	*Magnesium*	*K/P*	*Ca/P*	*Mg/P*	*K/Ca*	*K/Mg*	*Ca/mg*
1. 8/29 Grade I ..	2·38	0·847	2·90	2·07	0·773	3·38	21·9	13·5	4·23	6·5	4·0	1·3	0·83	1·6	1·9
2. 8/30 Grade I ..	2·37	0·928	4·24	2·41	0·702	2·60	25·3	12·4	3·02	9·7	4·7	1·2	1·1	2·5	2·4
3. 8/45 Grade I ..	2·45	0·740	3·43	2·18	0·738	2·68	23·6	12·9	3·38	8·8	4·8	1·4	0·94	1·9	2·2
4. 8/46 Grade I ..	2·44	0·504	3·70	1·70	0·551	1·89	26·4	10·4	2·84	13·9	5·5	1·5	1·3	2·8	2·2
5. 8/63 Grade V ..	3·42	0·564	2·23	3·14	1·02	1·85	13·9	16·9	4·59	9·0	9·1	2·4	0·56	0·95	1·7
6. 8/47 Grade II ..	2·95	0·813	3·07	3·25	1·04	2·62	18·8	17·1	4·59	7·2	6·5	1·7	0·56	1·3	2·2
7. 8/47 Grade III & V ..	3·87	0·650	3·28	2·14	0·859	2·48	23·3	13·1	4·41	9·3	5·2	1·8	0·91	1·6	1·8
8. 8/123 Grade III & V	2·66	0·729	2·96	2·66	0·986	2·28	17·6	13·6	4·24	7·1	5·9	1·8	0·66	1·3	1·9
Average of Grade I ..	2·41	0·755	3·56	2·00	0·691	2·64	24·3	12·3	3·36	8·2	4·6	1·3	1·0	2·2	2·1
Average of Other Grades	3·20	0·689	2·89	2·80	0·976	2·31	18·4	15·2	4·46	7·9	6·5	1·9	0·62	1·3	2·0

TABLE IX

Comparative Analysis of Marginal and Middle Portions of Tobacco Leaves

No. Location, Leaf Section		*On Moisture-free Basis*					*Percentage on Ash*				*Ratios*					
		Nitrogen %	*Phosphoric Acid* %	*Potash* %	*Lime* %	*Magnesia* %	*Phosphorus*	*Potassium*	*Calcium*	*Magnesium*	*K/P*	*Ca/P*	*Mg/P*	*K/Ca*	*K/Mg*	*Ca/Mg*
1. Uhana	Marginal	3·37	0·657	2·95	3·74	1·37	2·00	17·1	18·6	5·73	8·5	9·3	2·9	0·47	0·93	2·0
2. Uhana	Middle	2·29	0·773	3·67	4·03	1·55	2·11	19·0	18·0	5·81	9·0	8·5	2·8	0·54	1·0	1·9
3. Weeragoda	Marginal	3·17	0·697	3·11	3·55	1·23	2·03	17·3	16·9	4·93	8·5	8·3	2·4	0·52	1·1	2·1
4. Weeragoda	Middle	3·05	0·805	3·89	3·37	1·22	2·27	20·8	15·5	4·72	9·2	6·9	2·1	0·69	1·4	2·0
5. Central Camp	Marginal	3·19	0·579	3·08	3·58	1·24	1·77	17·9	17·9	4·12	10·1	10·1	2·3	0·51	1·3	2·6
6. Central Camp	Middle	3·88	0·744	3·28	3·40	1·24	2·18	18·3	16·3	5·00	8·4	7·5	2·3	0·57	1·1	2·0
Average-Marginal		3·24	0·644	3·05	3·62	1·28	1·93	17·4	17·8	4·93	9·0	9·1	2·6	0·51	1·1	2·2
Average-Middle		3·07	0·774	3·61	3·60	1·34	2·19	19·4	16·7	5·18	8·9	7·6	2·4	0·6[illegible]	1·2	2·0

TABLE X—Comparison of Papery and Normal Leaves

No. Unit/Allot, Grade		On moisture-free basis (Per Cent)					Percentage on ash				Ratios					
		Nitrogen	*Phosphoric Acid*	*Potash*	*Lime*	*Magnesia*	*Phosphorus*	*Potassium*	*Calcium*	*Magnesium*	*K/P*	*Ca/P*	*Mg/P*	*K/Ca*	*K/Ng*	*Ca/Mg*
1. 8/42	Papery	3·65	0·753	3·44	3·04	1·66	2·21	19·6	14·6	6·69	8·7	6·6	3·0	0·67	0·92	1·8
2. 8/63	Papery	4·37	0·683	2·73	5·01	1·58	1·62	12·5	19·4	4·09	7·7	12·0	2·5	0·33	2·0	2·8
3. 8/120	Papery	3·57	0·609	1·82	2·11	1·73	2·89	16·4	16·2	10·98	5·7	5·6	3·8	0·52	0·46	·89
4. 8/105	Papery	2·25	0·517	3·67	3·54	1·43	1·39	18·7	15·5	5·28	13·5	11·2	3·8	0·62	1·1	1·8
Average-	Papery	3·46	0·641	2·93	3·42	1·60	2·08	16·8	16·4	6·76	8·3	10·7	3·3	0·40	0·88	2·2
Average of Grade I (Tables VII & VIII)		3·38	0·751	3·53	2·06	0·688	3·09	24·3	12·2	3·43	8·0	4·0	1·1	1·0	2·2	2·2

TABLE XI—Comparison of Puckered and Normal Leaves

No. Unit/Allot, Grade		On moisture-free basis (Per Cent)					Percentage on ash				Ratios					
		Nitrogen	*Phosphoric Acid*	*Potash*	*Lime*	*Magnesia*	*Phosphorus*	*Potassium*	*Calcium*	*Magnesium*	*K/P*	*Ca/P*	*Mg/P*	*K/Ca*	*K/Ng*	*Ca/Mg*
1. 32/22	Puckered	3·48	0·699	2·45	4·33	1·32	2·09	13·9	21·1	5·41	6·6	10·1	2·6	0·33	0·77	2·3
2. 32/22	Normal	2·70	0·801	3·63	3·25	0·920	2·49	17·1	16·6	3·93	6·8	6·6	1·6	0·53	1·3	2·5
3. 12/127	Puckered	3·98	0·769	2·69	4·29	0·910	2·07	13·7	18·8	3·36	6·6	9·1	1·6	0·37	1·3	3·3
4. 12/127	Normal	2·28	0·862	3·23	2·92	0·698	2·71	19·3	15·0	3·01	7·1	5·5	1·1	0·66	1·9	3·0
Average-	Puckered	3·73	0·734	2·57	4·31	1·12	2·08	13·8	19·9	4·39	6·6	9·6	2·1	0·36	0·93	2·8
Average-	Normal	2·49	0·832	3·43	3·09	0·809	2·60	18·2	15·8	3·64	7·0	6·1	1·4	0·59	1·6	2·6