MANURIAL TRIALS WITH COTTON IN CEYLON—I

A. W. R. JOACHIM, Ph.D. (Lond.), Dip. Agric. (Cantab.),
AGRICULTURAL CHEMIST

COTTON is grown in Ceylon almost solely as a peasant crop and on a system of rotation. Yields are satisfactory on virgin soils, but after two or three seasons they fall to a level which render the cultivation of the crop, if not unremunerative, at any rate of little economic value. With the re-introduction by Government of a system of purchase of seed cotton from village cultivators at a fixed rate (at present Rs. 12·00 per cwt.), an interest in cotton cultivation has been re-awakened and larger areas are being put under the crop each year. With a view to determining whether yields could be increased with profit to the cultivator by the application of fertilizers, preliminary manurial trials of simple design were carried out on the crop during the 1936 *maha* season at two centres, *viz.*, the Vavuniya Experiment Station in the Northern Division and the Dambulla Experiment Station in the Central Division with the co-operation of the respective Divisional Agricultural Officers. The variety of cotton grown was Cambodia. The two centres afford a marked contrast in soil conditions and were hence selected for these trials. The soil at Vavuniya is a limestone-derived loam and the site quite level. At Dambulla, on the other hand, the land is undulating and the soil a gravelly loam of shallow and uneven depth due to erosion. The average annual rainfall for the year at Vavuniya is about 63 in. and at Dambulla 68 in. The greater part of the precipitation falls, at both centres, during the north-east monsoon from October to January.

COTTON FERTILIZER EXPERIMENTS IN OTHER COUNTRIES.

Fertilizer experiments with cotton in other countries have given variable results. In the U.S.A. (1) the following

important conclusions have been drawn as a result of nearly 3,000 fertilizer tests on the crop :—(1) fertilizers give about the same increases on all classes of soil, fertile and poor ; (2) small quantities of fertilizer give as large an increase as heavy dressings and with greater profit ; (3) farmyard manure alone and in combination with potash and superphosphates gives highest yields ; (4) mineral fertilizer mixtures up to 400 lb. per acre give profitable returns.

In Texas (2) which is a large cotton-producing state in the U.S.A., the results of 151 experiments showed that farmyard manure gives highest increases and profits. Superphosphate alone at the rate of 150 to 200 lb. per acre was the most profitable artificial fertilizer to apply. Cotton seed cake and nitrate of soda also gave increased yields. Potash fertilizers were not found essential and their application is not recommended except on soils deficient in this constituent. Recent experiments in South Mississippi (3) have however indicated that potash greatly reduced the percentage of cotton rust and wilt and thus increased the yield of crop. In South Africa (4) experiments with artificial fertilizers on cotton gave similar results to those obtained in the U.S.A. Phosphoric acid in the form of superphosphate and nitrogen as sulphate of ammonia proved to be distinctly beneficial while potash was not. Farmyard and green manure have also been found profitable in that country. Recent manurial trials in Trinidad (5) indicated that compost at the rate of 10 tons per acre gave highest yields of cotton. Of artificial fertilizers the best results were obtained with a complete fertilizer. The effect of potash was very marked, but the response to phosphoric acid was much less noticeable. Potash tended to improve the quality of the fibre. Trials carried out in the Island of St. Vincent (6) during 1934 and 1935 showed that only sulphate of ammonia (at the rate of 5 cwt. per acre), cotton seed meal and the complete fertilizer gave significant increases. Sulphate of potash and superphosphate alone gave no significant yield responses.

In Egypt (7) nitrogenous fertilizers applied as nitrate of soda proved to be most profitable, the increases varying from $1\frac{1}{2}$ to $2\frac{1}{4}$ cwt. per acre. In general, however, it is considered

that while " fertilizers do cause important increases in yields," they do so " only within the limits imposed by the factor or factors determining the yield level."

In India the value of farmyard manure, compost and green manure for cotton is well recognised. Artificial fertilizers give variable results depending on soil, climatic and cultural factors and on the variety of cotton grown. In the Sind (8) the application of compost ($7\frac{1}{2}$ cart loads per acre) along with sulphate of ammonia (up to 200 lb.) gave best results. An excessive supply of nitrogen seems to increase the susceptibility of the crop to cotton wilt (8).

EXPERIMENTAL

In the absence of any reliable data on cotton manuring in Ceylon, a scheme of trials was designed to test the essential fertilizer requirements of the crop under local conditions. The six treatments, were as follows :

1. Control. 2. Nitrogen alone as sulphate of ammonia at the rate of 2 cwt. per acre. 3. Phosphoric acid alone as superphosphate at the rate of 2 cwt. per acre. 4. Potash alone as sulphate of potash at the rate of $\frac{1}{2}$ cwt. per acre. 5. A complete mixture consisting of 2, 3 and 4 above. 6. Cattle manure at the rate of 5 tons per acre.

The artificial fertilizers were applied in the rows about a month after sowing, and the cattle manure at the time the area was ploughed. The experiment was laid out in four randomized blocks each comprising of six plots. The plot size varied at the two centres from $\frac{1}{3\frac{1}{3}}$rd to $\frac{1}{4\frac{1}{2}}$nd of an acre respectively owing to considerations of space. Border rows were allowed for, and shallow drains separated one plot from another in a block, while the blocks themselves, where contiguous, were separated from each other by deeper drains. The usual planting practice adopted in Ceylon was followed. Observations were recorded, as far as was possible, of the approximate rates of growth of crop, incidence of pests and diseases, rainfall, periods of flowering, setting of bolls, etc. in the various plots. No separate records of crop at each picking were kept, only the total yields in pounds of seed cotton per plot (to the nearest quarter lb.) being determined.

RESULTS AND DISCUSSION

The details of each experiment are described separately in papers II and III of this series. In this article the results of each trial will be briefly discussed and compared, and such conclusions drawn from the consideration of the combined data as would appear obvious. In table I below the results obtained from both trials are presented for comparison. The yield data of treatments showing significant increases over the control are indicated in bold type.

TABLE I

YIELDS OF SEED COTTON IN LB. PER ACRE

	Treatment	*Vavuniya*	*% Increase over Control*	*Dambulla*	*% Increase over Control*
1.	Control ..	667·8	—	307·8	—
2.	Nitrogen (Sulphate of ammonia) ..	**945·0**	41·5	**501·4**	62·9
3.	Phosphoric Acid (Superphosphate) ..	783·1	17·3	310·4	0·8
4.	Potash (Sulphate of potash) ..	796·0	19·2	284·1	–7·7
5.	Complete Mixture (2 + 3 + 4) ..	770·8	15·4	450·9	46·5
6.	Cattle Manure ..	**865·1**	29·6	**464·5**	50·9
	Mean *lb.*	804·5		386·5	
	Mean *cwt.*	7·18		3·45	
	Standard Error of mean	52·1		52·9	
	Standard Error (% of mean) ..	6·47		13·68	
	Significant Difference:				
	P = ·05 ..	157·1		159·2	
	P = ·02 ..	191·8		194·5	
	P = ·01 ..	217·1		220·4	

It will be observed that the average yield of seed cotton per acre at Vavuniya (804·5 lb.) is over twice that at Dambulla (386·5 lb.). This marked difference can be attributed largely to soil conditions. The average yield at Vavuniya is quite high when compared with the Ceylon average while even the Dambulla average is above the normal. At both centres nitrogen alone, applied as sulphate of ammonia at the rate of 2 cwt. per acre, gave highest yields. Cattle manure applied

at 5 tons per acre was the only other treatment which produced significant increases in yields. The increase with nitrogen alone was 277 lb. (approx. 2½ cwt.) per acre or 42 per cent. over the control at Vavuniya, and 194 lb. (approx. 1¾ cwt.) per acre or 63 per cent. over the control at Dambulla. With cattle manure the corresponding increases were 197 lb. or 1¾ cwt. and 157 lb. or about 1½ cwt. Neither potash nor phosphoric acid gave significant yield increases at either centre, though at Vavuniya these fertilizers appear to have had some beneficial effect. The complete mixture again, which one would normally have expected to give increases comparable to those of nitrogen alone, has not produced significant increases at either centre, although increases of 143 and 103 lb. per acre respectively were obtained as a result of this treatment at Dambulla and Vanuniya. The reasons for this disappointing result will be discussed in the papers to follow. By a strange coincidence, the absolute standard error of the mean and the significant differences for varying probabilities are about the same in both experiments, though the standard error expressed as a percentage of the mean is over twice as much at Dambulla as at Vavuniya. This observation can be attributed to the much greater soil heterogeneity of the Dambulla experimental site.

ECONOMICS OF MANURING

Working on the average figures obtained in these trials and reckoning on a price of seed cotton of Rs. 12·00 per cwt., of sulphate of ammonia and its application at Rs. 7·00 per cwt. and of cattle manure and its application at Rs. 3·00 and Rs. 2·50 per ton at Vavuniya and Dambulla respectively, the economic returns from manuring cotton with 2 cwt. of the former and 5 tons of the latter per acre, assuming that the whole crop was first grade cotton, are Rs. 15·00 and Rs. 9·00 per acre respectively at Vavuniya, and Rs. 6·00 and Rs. 4·00 per acre respectively at Dambulla. These figures are, however, only indications of what returns may be expected from manuring cotton.

SUMMARY AND CONCLUSION

Preliminary manurial trials on cotton at two centres in Ceylon affording a marked contrast of soil type and configuration—at Vavuniya on a level, uniformly deep, lime-stone-

derived loam and at Dambulla on an undulating, unevenly shallow, lateritic gravel loam—have indicated that at both places, significant yield increases and enhanced economic returns are obtained by the application of sulphate of ammonia at the rate of 2 cwt. per acre and cattle manure at the rate of 5 tons per acre. The profits from manuring varied from Rs. 4·00 to Rs. 15·00 per acre. In respect of crop response to artificial nitrogen alone these results conform with those obtained in Egypt and St. Vincent, and with those of most cotton-producing countries in respect of its response to farmyard manure. Further experiments are, however, necessary to determine the optimum quantities and times of application of these manures on varying soil types, and the proportions of other fertilizers they require to be supplemented with to produce the best results from the standpoints of yield and quality of cotton and economic returns.

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