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Manuring of Sugarcane in Malwa

by

SARDAR SINGH
Institute of Plant Industry, Indore

Introduction: Madhya Bharat is situated in the centre of the Indian Union extending over an area of 47,000 square miles. The central part of this State is called Malwa Plateau situated at a height of 1,200 to 1,800 ft. above sea level. It consists of black cotton soils varying in depths from 1 to 6 feet and receives an annual rainfall of about 30 inches. On account of its high moisture-retaining capacity, the main crops of wheat, cotton, groundnut and jowar (sorghum) etc., are grown under rainfed conditions while sugarcane and other garden crops are cultivated on irrigated lands. The total area under sugarcane is about 55 thousand acres representing about 14% of the irrigated area of the State. The yields of indigenous cane varieties were only 10 to 12 tons per acre, but as a result of evolution of improved hybrid canes developed at the Central Sugarcane Research Institute at Coimbatore, the yields have increased by about 200 to 400%, but still it is not equal to the other sugarcane-growing areas of the country such as U. P., Bihar and Madras etc.

The yields of the improved varieties can further be raised by the application of nitrogenous manures both organics and inorganics. Sethi in U. P., India, (1937) reported that there is a general consensus of experimental results to show that part of nitrogen should be given in the organic form particularly as castor or groundnut cake, which proved superior to bulky manures. Rege in Bombay, (1941) stated that since the application of ammonium sulphate alone deteriorates the quality of the juice, mixture of inorganic manures with organics like oilcakes was best for sugarcane. Carey and Robinson (1953) in British Guiana found that with dressings of 2, 4, 6 and 8 cwt. per acre of ammonium sulphate, the percentage of sucrose fell on an average by 0·01, 0·10, 0·23 and 0·51 respectively.

Since no such work on sugarcane was done in this part of the country, an experiment was started at the Institute of Plant Industry, Indore, in 1948–49. The bulky manures, farmyard manure and compost, were applied as basal doses while mixtures of ammonium sulphate, groundnut cake and ammonium sulphate and castor cake were applied as top dressings.

Experimental layout and results: The treatments consisted of F. Y. M. (0·5% N) and Farm Compost (1·0% N) applied as basal dressing at 50 lb. N per acre, and two mixtures of ammonium sulphate plus groundnut cake and ammonium sulphate plus castor cake applied as top dressing to supply 50, 100, 150 and 200 lb. N per acre, in two instalments, once at the time of planting and the other at earthing-up after about four months. The mixtures were made in such a way that half the quantity of nitrogen was from ammonium sulphate and the remaining half from groundnut or castor cakes. The variety of sugarcane used was Co. 419 which has been recommended as the most suitable for this tract. The treatments were in three replications in a simple randomised block design in each season.

For combined analysis, the plotwise yields have been converted in tons per acre and these are given in Table 1.

As a result of the statistical analysis, it was found that the differences in the cane yield obtained in different seasons were highly significant. The yields obtained during 1948 – 49 were significantly lower than those of 1950 – 51 or 1951 – 52.

There were no significant differences in the cane tonnage due to the two bulky manures applied before sowing or to the two manure mixtures being applied as top dressings

With regard to the effect of various doses of nitrogen, it was found that the higher levels of 100, 150 and 200 lb. nitrogen per acre increased the yield significantly over control (50 lb. N per acre). However, there were no appreciable differences in their mean yields. The application of 200 lb. N gave a lower yield than 150 lb. N per acre, although it is not statistically significant, as will be seen from Table 2 given below.

TABLE 2.

Cane tonnage per acre

Levels of N.	Mixtures. Ammonium sulphate groundnut cake.	Ammonium sulphate Castor cake.	Average.
50	25·16	22·98	24·07
100	28·78	27·41	28·09
150	28·91	28·78	28·84
200	28·02	27·91	27·96
Average	27·71	26·77	

Standard error for levels: 0·82 C. D. 2·37
Standard error for mixture: 0·58 Differences not significant.

Treatments	1951–1952			Grand Total	Average
	II	III	Total		
1. Farm Compost @	35·24	26·55	91·95	225·00	25·00
2. ,,	34·40	33·71	100·95	244·76	27·19
3. ,,	23·96	30·90	91·11	268·07	29·78
4. ,,	36·89	37·68	105·52	269·41	29·93
5. ,,	25·65	31 06	81·04	223 25	24·80
6. ,,	28·99	28 30	90·84	259·97	28·88
7. ,,	32·44	29·36	97·10	257·25	28·58
8. ,,	22·84	26·87	72·18	243 75	27·08
9. F. Y. M. @ 50 l	30·32	34·08	92·33	227·91	25·32
10. ,,	33·60	33·02	102·02	272·99	30·33
11. ,,	25·44	29·89	91·16	252·40	28·04
12. ,,	31·06	22·68	76·58	235·00	26·11
13. ,,	22·47	27·19	69·45	190·40	21·16
14. ,,	34 87	30·74	93·01	233·60	25·95
15. ,,	28·88	26·98	83·58	260·83	28·98
16. ,,	34·29	34·56	88·67	258·65	28·74

AG = Mixt

AC = Mixt

	M. S. S.	Ratio
Blocks	5·03	..
Seasons	1,121·99	46·00 **
Levels	166·62	6·83 **
Mixtures	31·96	1·30
Basal dressings	24·74	1·01
Int. Levels ×	9·12	0·37
,, ,, ×	4·96	0·20
,, Mixtures ×	3·30	0·13
,, Level ×	64·29	2·63
,, Levels ×	57·45	2·35 *
Error	24·39	..

** Significant at 1

(÷) The sum of squ ound to be significant.

Standard error

,, ,,

Standard error

Standard error

Interactions: The differential responses for various treatment combinations were not statistically significant except the interaction between the levels of nitrogen and the seasons, as will be observed from the figures given in table 3.

TABLE 3

Cane tonnage per acre

Levels of N.	Seasons. 1948—49.	1950—51.	1951—52.	Average.
50	15·51	28·80	27·90	24·07
100	22·07	30·00	32·20	28·09
150	25·04	31·26	30·24	28·84
200	24·06	31·26	28·58	27·96
Average	21·67	30·33	29·73	

Standard error for interaction: between levels of N and seasons 1·42 C. D. 4·11

It will be evident from the above figures that the levels of nitrogen responded differeently in each season and each level gave significantly lower yields in 1948 – 49 than in 1950 – 51 or 1951 – 52.

Response curves and optimal doses: The response curve helps a great deal to select the suitable levels of treatments in agronomical trials. The characteristic of a response curve is that it shows an upwards trend with an increase in the fertiliser dosage but the rate of increase declines for the higher doses.

In this paper the effect of graded doses of nitrogen on the cane tonnage has been shown by means of polynomical curves of the form $Y = a + bx + cx^2$ fitted to the observed mean values for three seasons, for both the mixtures Am. sulphate + groundnut cake (abreviated as AG) and Am. sulphate + castor cake (abreviated as AG) and Am. sulphate + castor cake (abbreviated as AC) and Am. sulphate + castor cake (abbreviated as AC) and have been represented in Fig. 1.

The curve for mixture 'AG' shows that the response due to 100 lb. N per acre was the highest but it declined with the subsequent dose of 150 lb. N. A further fall in the curve was noted with the application of 200 lb. N indicating thereby that the maximum yields were reached at 150 lb. N and no further gains would be achieved by exceeding this limit under Malwa soil and climatic conditions.

The second curve drawn for mixture 'AC' showed that although the yields with this mixture are lower than that of mixture 'AG' it responded better so that at the highest level of 200 lb. N per acre, the yield was the same for both the mixtures i. e. the lower doses of mixture 'AG' proved more effective than the same doses of mixture 'AC', but the highest dose of the latter has a lesser depressing effect than the same dose of the former.

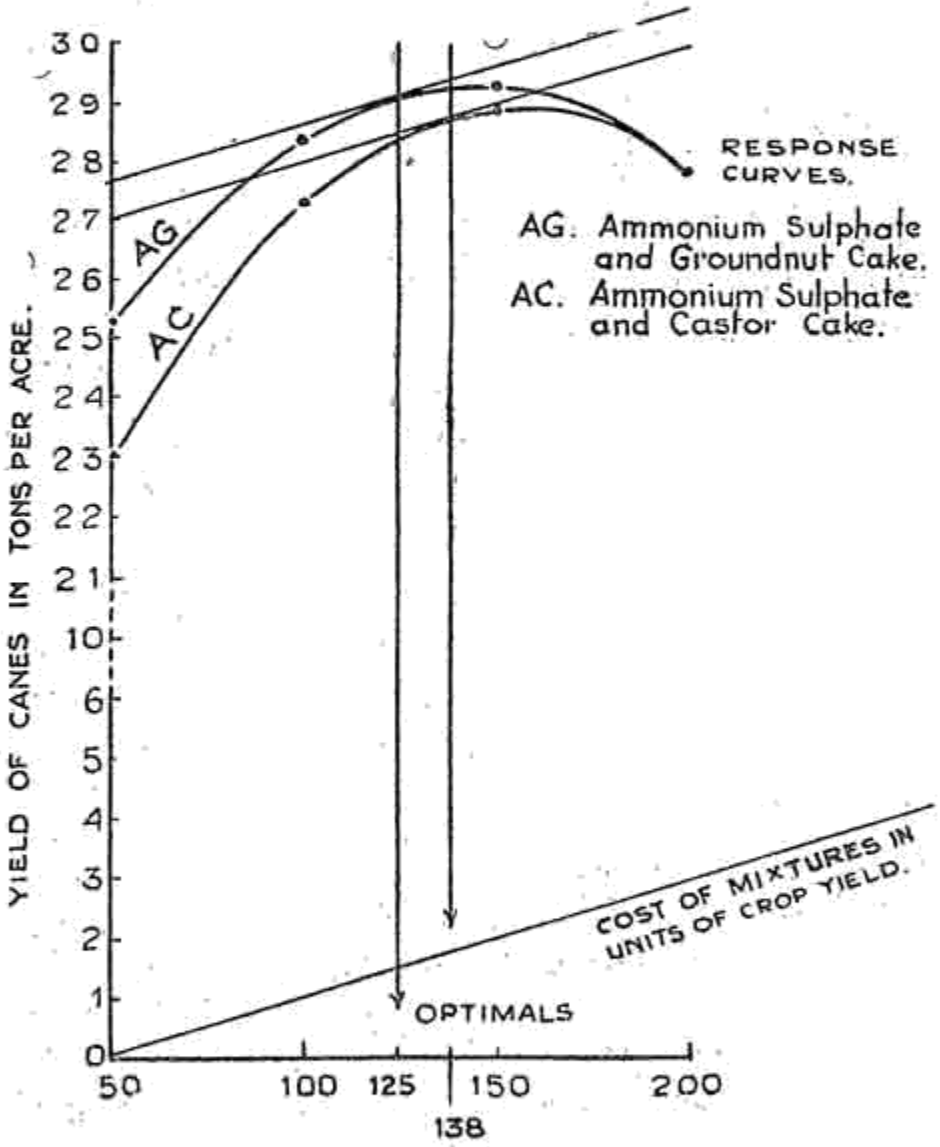

FIG. 1. RESPONSE CURVES SHOWING THE COST OF THE MIXTURES AND THE TANGENTS DETERMINING THE OPTIMAL DRESSINGS.

Normally the most desirable dose of the manure or the fertiliser is that which gives the maximum net profit to the grower and since the relative prices of the manures and the crop produce are apt to fluctuate from season to season, the most remunerative dose will also vary accordingly. Hence in order to make this dose somewhat stable, Finney (1953) suggested that if the cost of the

manure or the fertiliser is expressed in terms of the weight of the crop produce of equal value, the cost of any dressing may be represented by a straight line and the maximum profit will be obtained for the optimal dressing which can be determined by drawing a perpendicular to the horizontal axis from the point where a line parallel to the cost line is tangent to the curve, as has been shown in Fig. 1. Such optimal doses for the two mixtures Am. sulphate + groundnut cake and Am. sulphate + castor cake were found to be 125 lb. N and 138 lb. N per acre respectively. These optimals synchronised with the actual calculated values as will be seen from the Tables 4 and 5.

TABLE 4

Economics with the mixture, Ammonium sulphate and groundnut cake

Levels of N		Expected cane tonnage acre	Extra tonnage over control	Value of extra produce	Cost of manure mixture*	Profits (+) Loss (—)
				Rs. A. P.	Rs. A. P.	Rs. A. P.
Control	50	25·3	..	..	..	..
	100	28·4	3·1	155 0 0	47 14 7	107 1 5 (+)
	(125)	29·1	3·8	190 0 0	71 13 10	118 2 2 (+)
	150	29·3	4·0	200 0 0	95 13 2	104 2 10 (+)
	200	27·9	2 6	130 0 0	143 11 9	13 11 9 (—)

TABLE 5

Economics with the mixture, Ammonium sulphate and castor cake

Control	50	23·0	..	..	..	..
	100	27·3	4·3	215 0 0	47 14 7	167 1 5 (+)
	(138)	28·8	5·8	290 0 0	84 12 5	205 3 7 (+)
	150	28·9	5·9	295 0 0	95 13 2	199 2 10 (+)
	200	27·9	4·9	245 0 0	143 11 9	101 4 3 (+)

* Cost of additional manuring over the lowest dose of 50 lb. N per acre.
( ) Optimals found from the response curves in Fig. 1.

Prices (average of three seasons):

Ammonium sulphate (20% N)	..	Rs. 11—7—0 per maund (82 lb.)
Groundnut cake (7% N)	..	,, 7—0—0 per maund (,,)
Castor cake (5% N)	..	,, 5—0—0 per maund (,,)
Selling price of cane	..	,, 50—0—0 per ton.

Discussion: Amongst several agronomic practices that contribute to improving crop yields, manuring is the one major factor in sugarcane production. The evidence on the subject proves beyond doubt that for getting better yields of sugarcane the use of both organic and inorganic manures is indispensable. In the present investigation the effect of seasonal

variation was found to be significant, due mainly to lodging and the damage caused by rats during 1948—'49.

The two bulky manures, F. Y. M. and Farm Compost, or the two mixtures, Ammonium sulphate + groundnut cake and Ammonium sulphate + castor cake, did not show any significant variation in their responses. Similar results have been reported by Joshi (1953) from tht experiments conducted at Tharsa and Adhartal farms in Madhya Pradesh with different kinds of manures and oil cakes. The same conclusion has been drawn from the results obtained at Gorakhpur and Kalai in U. P.

With regard to the effect of levels of nitrogen, it was noted that the yield increased with an increase in the dosage of nitrogen upto 150 lb. N per acre, but the differences were significant only over control (50 lb. N per acre). A further increase to 200 lb. N per acre, though it gave a significantly higher tonnage over control, slightly depressed the yields as compared to the dose of 150 lb. N. This fact has also been noted at Shahjahanpur in U. P. and in Madras where higher doses above 200 lb. N per acre affected the cane tonnage as well as sucrose content.

The utility of any dose of manure or fertiliser depends upon the financial returns after allowing for its cost. There are three possible ways to find out the most economical dose of any manure. In the first the cost of manure is deducted from the value of the extra produce, based on the actual market prices. The optimal dose thus determined will vary from season to season. The second is based on the formnla $\frac{q}{p}$ suggested by Sukhatme (1941) where q is the cost per lb. of nitrogen and p the price per lb. of the produce. Here too, the ratio will change from season to season The third and most useful method has been suggested by Finney (1953) in which the cost of the manure, if exressed in terms of the weight of the crop produce of equal value, the variation in the optimal doses from season to season would be minimised and the optimum dose would be more or less stable.

Summary: In a manurial trial on sugarcane Co. 419, farmyard manure and farm compost were applied as basal dressings at 50 lb. N per acre and the mixtures of Ammonium sulphate + groundnut cake and Ammonium sulphate + castor cake were applied in graded doses of nitrogen varying from 50 to 200 lb. per acre as top dressings in two instalments. For the expected yield values polynomial curve was fitted for each mixture and the optimal dose was found out by

drawing perpendicular to the base line from a point on each curve where the tangent parallel to the cost line touches it. No non-zero level was included and the profits were calculated over the minimum dose of 50 lbs. N usually used by the cultivators. The results did not indicate any marked differences in the cane tonnage with the application of either farmyard manure or farm compost.

The two manure mixtures, Ammonium sulphate + groundnut cake and Ammonium sulphate + castor cake did not show any significant variation in their responses.

The application of higher doses of 100, 150 and 200 lb. N increased the yield significantly over control (50 lb. N), but the maximum was obtained by the application of 150 lb. N per acre.

Wherever the economics of manuring is to be studied the method mentioned by Finney seems to be of great utility for stabilising the optimals. In this trial the optimals by this method for Ammonium sulphate + groundnut cake and Ammonium sulphate + castor cake were found to be 125 lbs. and 138 lb. N per acre respectively.

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