

Manurial Experiments on Rice

1. Application of Cakes as Nitrogenous Manures

By

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Introduction. Vizagapatam in area is third in importance as a rice-producing district in the Madras Province. This crop occupies 7,429,000 acres. It is the staple food of the population and is supplemented by Ragi (*Eleusine coracana*) and pearl millet (*Pennisetum typhoides*). The average yield of rice in India is low when compared with those of other countries, such as Spain and Italy. The application of artificial fertilisers increases yields but their extensive use is neither economical nor beneficial to the soil in the long run.⁽¹⁾ In India organic manures are the most desirable for the improvement of soil as well as for yields of crops. Among the many organic manures, oil cakes are very popular in this district. The extent of their application is naturally limited to their availability. In Vizagapatam District about 36,000 tons of groundnut cake are available per annum. Besides this, other cakes such as castor cake and Pungam cake (*Pongamia glabra*) are also available in smaller quantities. It is necessary to find out which of these are the most suitable to the crop under the conditions of soil and climate of this district. Before recommending any particular level of nitrogen on a large scale, it is necessary to evaluate the most profitable amount of the manure commensurate with the cost of its application.

To find out the optimum amount and the type of cake to be applied for increasing the production in rice, two experiments were conducted at the Agricultural Research Station, Anakapalle from the year 1942—43 to 44—45. The results of these experiments are presented in this paper.

Review of Manurial Experiments in Madras. The Paddy Specialist and the Government Agricultural Chemist⁽²⁾ have recently reviewed the manurial experiments conducted during the period 1930 to 1940, at the six of the Agricultural Research Stations of the Province and it is not considered necessary to cover the same field now in any detail. These experiments fall into three groups i. e. (1) application of nitrogenous manures alone in the form of green manure or cake or ammonium sulphate, (2) Combination of organic and inorganic nitrogen, (3) Nitrogen and Phosphate combinations. The summary of conclusions based on these experiments for nitrogenous manures is presented in table I. These conclusions are limited to the experiments conducted during the period referred to above and to the tract covered by the respective Agricultural Stations.

TABLE I.

Station.	Manures recommended and dosage per acre.
Maruteru	... Green manure 4,000 lbs. or G. N. Cake 675 lbs. or ammonium sulphate 100 lbs.
Samalkot	... Green manure 6,000 lbs. or ammonium sulphate 150 lbs.
Anakapalle	... Green manure 6,000 lbs. to 8,000 lbs.
Aduthurai	... Ammonium sulphate 150 lbs. or green manure 4,000 lbs.
Coimbatore	... Ammonium sulphate 150 lbs. or G. N. Cake 425 lbs. or green manure 6,000 lbs.
Pattambi	... Ammonium sulphate 150 lbs. or G. N. Cake 425 lbs. or green manure 5,000 lbs.

In general, it may be said, that cakes are superior to the application of green leaf alone and a combination of the two is better than either. At Pattambi it was noted that groundnut cake and castor cake were more economical than neem cake. An experiment conducted at Agricultural Research station, Palur, over a period of 14 years, indicated that continuous application of ground nut cake and castor cake at 500 lbs. per acre did not show any cumulative or deleterious effect and the yields of rice increased by 16%.

Experiments at Anakapalle. In one experiment, groundnut cake, Pungam (*Pongamia glabra*) cake and Castor cake were tried as manures on a pure line A. K. P. 3. These cakes were applied to supply 0 lbs. 20 lbs. 40 lbs. and 60 lbs. nitrogen per acre. This experiment was on a factorial design with six replications, in randomized blocks. In the second experiment, groundnut cake to supply 0 lbs. 30 lbs. and 60 lbs. nitrogen was applied to five important pure lines grown extensively in the tract viz. G. E. B. 24, A. K. P. 3, A. K. P. 6, B. A. M. 6 and B. A. M. 8. This experiment was also laid out on a factorial design with four replications in randomized blocks.

The local practice is to raise dry nurseries and transplant the seedlings, when the South West Monsoon sets in and water becomes available in the channels. The same practice was adopted in the present experiments also. The nurseries were sown early in July but the transplanting were at times delayed due to late setting of the monsoon; when the period in the nursery was prolonged and the post transplantation period was reduced. It will be shown later that this transplantation period is an important factor in determining the yields of paddy in this tract. The data from Experiment I are presented in table II below :

TABLE II.
Yield of grain and straw in lbs. per acre.

Levels of Nitrogen.	Yield of grain/straw in lbs. per acre and percentage increase of yield over the standard.							
	1942-43.		1943-44.		1944-45.		Average of three years.	
0 lbs.	2380/2510	0	1744/2325	0	1814/2296	0	1979/2367	0
20 lbs.	2745/2946	15/17 %	2260/2851	30/22 %	2135/2733	15/19 %	2380/2843	20/19 %
40 lbs.	3102/3254	30/30 %	2704/3297	56/42 %	2508/3539	30/54 %	2771/3363	38/42 %
60 lbs.	3478/3758	46/49 %	2992/3624	72/56 %	2802/4300	46/89 %	3091/3894	56/65 %
Significance	Yes	...	Yes	...	Yes
Critical difference	208/436		219/310		91/373			

The data presented in table II indicate that oil cakes in any form applied, on nitrogen basis, benefit the rice crop and increased levels of nitrogen increase the yields of grain and straw whatever be the nature of the cake. There was no significant interaction between kinds of cake and levels of Nitrogen.

TABLE III.
Yields of grain and straw in lbs. per acre.

Levels of Nitrogen.	Yield of grain/straw in lbs. per acre and percentage increase of yield over the standard.							
	1942-43.	1943-44.	1944-45.	Average.				
0 lbs.	2324/2600	0	1320/1810	0	1733/3184	0	1792/2531	0
30 lbs.	2761/3165	19/22	1891/2824	43/56	2086/3909	20/23	2246/3299	27/34
60 lbs.	3068/3839	32/48	2330/3112	76/110	2343/4596	35/44	2580/4085	48/68
Mean	2718/3201	17/23	1847/2118	40/56	2054/3896	18/22	2206/3305	25/34
Significance	Yes	...	Yes	...	Yes
Critical difference	296/361		251/466		122/784			

VARIETIES.

B. A. M. 8	2985/3499	1918/3316	2224/4033	2376/3616
A. K. P. 6	2895/3210	1950/3006	1957/3119	2267/3345
A. K. P. 3	2614/3048	1793/2515	2000/3572	2136/3046
B. A. M. 6	2604/3167	1972/2657	2053/4161	2209/3328
G. E. B. 24	2491/3081	1604/2567	2032/3894	2042/3181
Significance	Yes	Yes	Yes/No	
Critical difference	246/380	281/414	158/...	

The data presented in table III show again that higher doses of groundnut cake increased the yields progressively. Among the varieties under test B. A. M. 8 and A. K. P. 6 gave significantly higher yields than the rest.

It was generally noted that application of about 750 lbs. groundnut cake, to supply 60 lbs. nitrogen per acre tended to increase vegetative growth and the crop was then liable to lodge.

Economics. The cost of manure applied, the net increase in yield over the control and the net profit realised at the market rates prevailing at time of the experiment are calculated and the data are presented in table IV below :—

TABLE IV.
Economics of Manuring.
(a) Kinds of cake and levels of Nitrogen.

Kind of cake.	Levels of nitrogen.	Cake applied in lbs. per acre.	Increased yield of Grain/straw over standard in lbs.	Money value of the increased yield.	Cost of Nitrogen applied	Profit.
Groundnut cake ...	20	248.3	421/565	32-14-9	8-2-9	24-12-0
	40	496.6	813/1029	63-1-2	16-5-6	46-11-8
	60	745.0	1177/1599	92-1-0	24-8-3	67-8-9
Castor cake ...	20	403.0	366/395	27-14-9	9-13-4	18-1-5
	40	806.0	820/1077	61-9-0	19-10-8	41-14-4
	60	1209.0	1180/1458	91-4-10	29-8-0	61-12-10
Pungam cake ...	20	450.4	399/441	30-8-2	6-4-4	24-3-10
	40	901.4	782/859	59-12-3	12-8-8	47-3-7
	60	1352.1	1064/1547	13-14-10	181-3-0	65-1-10

(b) Varieties and levels of Nitrogen.

Variety.	Levels of nitrogen.	Cake applied in lbs. per acre.	Increased yield of Grain/straw over standard in lbs.	Money value of the increased yield.	Cost of Nitrogen applied.	Profit.
G. E. B. 24 ...	30 N.	372.5	391/695	31-11-5	12-4-2	19-7-3
	60 N.	745.0	720/1498	59-14-6	24-8-4	35-6-2
B. A. M. 6 ...	30 N.	372.5	582/642	44-8-8	12-4-2	32-4-6
	60 N.	745.0	852/1508	69-1-9	24-8-4	44-9-5
A. K. P. 3 ...	30 N.	372.5	450/802	36-8-3	12-4-2	24-4-1
	60 N.	745.0	821/1595	67-8-5	24-8-4	43-0-1
A. K. P. 6 ...	30 N.	372.5	546/567	41-8-1	12-4-2	29-3-11
	60 N.	745.0	968/1573	77-7-11	24-8-4	52-15-7
B. A. M. 8 ...	30 N.	372.5	748/1134	59-5-2	12-4-2	47-1-0
	60 N.	745.0	1024/1560	81-4-3	24-8-4	56-11-11

Castor cake valued at Rs. 2-7-0 per 100 lb.

Groundnut cake valued at Rs. 3-4-8 per 100 lb.

Pungam cake valued at Rs. 1-6-3 per 100 lb.

Grain valued at Rs. 6-14-2 per 100 lb.

Straw valued at Rs. 0-11-0 per 100 lb.

Discussion In addition to the conclusions given later, there are some other important indications from these experiments. Yield in crops is a complex character and is the net result of a number of interacting factors. In addition to the supply of necessary nutrients, in the form of manure and water, there are other factors which bear a profound significance on yield. In our country climate is one such. The climatic effects are more pronounced in districts like Vizagapatam with regard to crops like rice where successful cultivation depends mainly on the monsoon. This district has no assured water supply and the rice planting gets often delayed; when there is a delay in the break of the South West Monsoon. In the late planted crop the post-transplantation period till flowering is short and this affects the yields adversely. In seasons of good rainfall and weather conditions, when the post-transplantation period is long, the yield of paddy is fairly high. In such seasons, the number of tillers per plant, height of plant, length of earhead and number of grains per earhead are generally greater than in seasons of low rainfall and late planting. Under the latter conditions, manuring the field with cakes is very helpful. Increase in yields brought about by manuring in such seasons is much more pronounced than the increase in normal seasons. However one very important fact was that heavy manuring in adverse seasons did not bring up the rice yields to the level of the yields from unmanured plots, recorded in good seasons (vide table II and III). It is a matter for future investigation, whether the increased yield brought about by manures, or seasons is favourably affecting the yield attribute. For instance, at Berhampur addition of manures increased the tillering by 24%, height by 23%, length of panicle by 3%, number of grains by 5.7% and the yield of grain by 56% and the straw-yield by 59%. It is thus evident that the different yield attributes are not all affected to the same extent. Field observations indicate that in seasons of low rainfall and late planting, tillering and height are increased by manuring but such increases do not appear to reach the levels attained normally without manuring in good seasons. Weather in relation to manuring will further be considered in a later paper.

Summary and Conclusions. Two experiments were conducted at the Agricultural Research Station, Anakapalle from 1942—43 to 1944—45 to determine (i) the optimum quantity of nitrogen required for the paddy crop and the response of five popular varieties to different levels of nitrogen in the forms of groundnut cake and (ii) the influence of different forms of cakes with different levels of nitrogen on a medium duration variety. The following are the conclusions.

- (i) Concentrated organic manures like cakes when applied to paddy gave increased yields.
- (ii) Increased doses of nitrogen from 0 lb. to 60 lbs. gave progressive increases in yield irrespective of the nature of cake.

- (iii) There was no interaction between forms and levels of nitrogen between levels of nitrogen and varieties.
- (iv) Among the five popular and widely-grown varieties of rice in in the Vizagapatam District, B. A. M. 8 gave the maximum response, closely followed by A. K. P. 6.
- (v) In seasons of delayed planting the post-transplantation period was always short. The increase in yields due to manures was greater in such delayed plantings than in that of normal years.
- (vi) Of the five varieties B. A. M. 8 and A. K. P. 6 gave greater returns.
- (vii) The economics of manuring indicated that application of groundnut cake @ 60 lb. Nitrogen resulted in a net profit of Rs. 68/- per acre.
- (viii) Application of groundnut cake is recommended for increased rice production, especially under late-planted conditions. Though increased doses upto 60 lb. Nitrogen per acre result in increased yields, field observations indicated that it is better to limit the manuring to 40 lbs. of nitrogen per acre so as to avoid lodging and consequential loss in quality and quantity of grain, especially in years of heavy rainfall or on lands subject to inundation.

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