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Manurial Experiments on Rice

III. Application of green manures in combination with Phosphates *

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To maintain the food supply for an ever increasing population every endeavour for conserving the essential elements of soil fertility will have to be made, more so, in these days of acute food shortage. The productive power of soils is steadily reduced when successive crops are grown and no adequate manuring is made. Organic matter is the sheet anchor of soil

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fertility in this tropical climate. The soils in almost the whole of Madras Presidency are generally deficient not only in organic matter but also in nitrogen. (1) For replenishing the organic matter depleted from the soils green manuring is the cheapest way. Green leaf manures not only supply essential plant nutrients but also improve the physical structure of the soils. The oxidation of manures resulting from the decomposition of green manures is said to assist the rendering of elements already in the soil more available as plant food and has a stimulating effect on the activities of beneficial organisms. Green manure in combination with phosphate fertilisers was found to yield best results in several places notably at Agricultural Research Stations, Samalkot and Manganallur (2). Among phosphatic manures the results with superphosphate and bonemeal was found to be encouraging in their direct and residual effects. Hutchinson and Milligun (3) showed that the addition of superphosphate to green leaf promoted its decomposition better even in a season when the moisture content is not high enough to allow of rapid decomposition of the green manure crop. Work at Pusa indicated that under natural conditions phosphates in organic combination became more available to plants. To test these findings at Anakapalli and to find out:

(1) The optimum quantity of green leaf (sunnhemp) required for recording maximum yields in paddy, (2) whether the application of phosphatic manures is necessary in addition to green leaf, (3) the form and quantity of phosphatic manures to be applied and (4) the economies of green manuring, an experiment was laid out at the Agricultural Research Station, Anakapalle in 1937-38 and continued for a period of five years. The results of the experiment are summarised below:—

Material and Method: There were twenty treatments in all, green leaf and Phosphoric acid treatments being tried alone and in combination (a) 3 levels of green leaf, viz., 4,000 lbs., 6,000 lbs. and 8,000 lbs., sunnhemp per acre, (b) two forms of phosphoric manures as bonemeal-superphosphate, (c) two levels of phosphoric acid viz., 10 and 20 lbs., phosphoric acid and (d) a control, no manure. The layout was a factorial design replicated four times. The planting was done with 6" spacing either way. The experiment was continued year after year in the same field. Seedlings from a rainfed nursery, which is common in this district were planted every year. Since the raising of the seed bed depended upon receipt of rains and plantings could be done only when water was available in the diversion channels which are full only if the monsoon is favourable, ages of seedlings at planting and dates of planting differed in each year. The experimental plots were dug out and turned in every year and the required amount of green leaf was spread over the surface in the treated plots and trampled in 3 or 4 days prior to planting. Bonemeal was also applied along with the green leaf. Superphosphate was applied at planting time. The variety grown was G. E. B. 24.

Results and discussion: The main factors that are responsible for difference in yields of paddy in Vizagapatam district are (a) Manuring, (b) the age of seedlings and (c) time of planting. Each factor is dealt with separately below:—

(a) *Effect of manuring:* The figures presented in the table (1) below indicated that the response to green leaf manuring was marked and that increased doses of green leaf contributed to increased grain yields. Increases due to addition of small quantities of either bonemeal or superphosphate were insignificant and erratic. Superphosphate, however, tended to give slightly better yields than bonemeal on the same phosphoric acid basis. There was no interaction between green leaf and the different kinds or doses of phosphatic manures. Moreover one of the good points in green leaf manuring was reported to be its capacity to bring into soluble form the available phosphoric acid in the soil. The beneficial effect of green manuring on grain yields was more marked in years of belated rainfall and late planting conditions.

TABLE I.
Grain yields in pounds per acre
1. Green leaf.

Treatment.	1937-'38.	1938-'39.	1939-'40.	1940-'41.	1941-'42.
8000 lb. per acre	1915	3367	1989	3437	2476
6000 lb. per acre	1918	3117	1762	3007	2354
4000 lb. per acre	1719	2527	1523	2648	2039
0 lb. per acre	1360	2146	954	2182	1521
General Mean	1728	2786	1552	2818	2097
Standard error of treatment mean	37.00	41.95	37.28	38.48	40.48
Critical difference at P=0.05	54.83	108.64	105.84	109.45	115.00
2. Phosphates.					
Super 20 lb. phosphoric acid per acre	1671	2275	1603	2816	2210
Super 10 lb. phosphoric acid per acre	1721	2827	1564	2939	2162
Bonemeal 20 lb. phosphoric acid per acre	1796	2844	1607	2788	2004
Bonemeal 10 lb. phosphoric acid per acre	1707	2777	1506	2747	2080
No phosphoric acid	1688	2724	1482	2803	2030
General mean	1728	2789	1552	2818	2097
S. E. of Treatment mean	41.64	46.88	41.64	43.02	45.26
Critical difference at P=0.05	61.46	132.58	118.23	122.15	129.00

With regard to straw yields in years when plantings were delayed as in 1939 the increases in yields in green manured plots seemed to be more as in the case of grain yield.

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

Treatment	1937—'38		1938—'39		1939—'40	
	Straw yield per acre	% increase over no manure	Straw yield per acre	% increase over no manure	Straw yield per acre	% increase over no manure
1. No manure ...	1760	0	2704	0	1495	0
2. Bonemeal to supply 10 lb. P_2O_5 ...	1863	6	2482	-8	1457	-2
3. Bonemeal to supply 20 lb. P_2O_5 ...	1944	10	2852	5	1634	9
4. Super to supply 10 lb. P_2O_5 ...	1666	-5	2482	-8	1506	1
5. Super to supply 20 lb. P_2O_5 ...	159	-10	2666	-1	1497	1
6. Green leaf at 4000 lb. ...	2130	21	3222	19	1881	26
7. Green leaf - 4000 lb. + bonemeal to supply 10 lb. P_2O_5 ...	2426	38	3481	28	2105	41
8. Green leaf to supply 20 lb. P_2O_5 ...	2204	25	3555	31	2180	46
9. Green leaf + super to supply 10 lb. P_2O_5 ...	2482	41	3777	40	2099	40
10. Green leaf to supply 20 lb. P_2O_5 ...	2222	26	3630	34	2053	37
11. Green leaf at 6000 lb. per acre ...	2444	39	4704	74	2287	-53
12. Green leaf at bonemeal to supply 10 lb. P_2O_5 per acre ...	2555	45	4555	68	2493	67
13. Green leaf at 20 lb. P_2O_5 per acre ...	2640	50	4593	69	2471	65
14. Green leaf + super 10 lb. P_2O_5 per acre ...	2648	50	4744	75	2546	-70
15. Green leaf + super 20 lb. P_2O_5 per acre ...	2611	48	4744	74	2484	-66
16. Green leaf at 8000 lb. per acre ...	2555	45	4777	77	2677	79
17. Green leaf + bonemeal to supply 10 lb. P_2O_5 per acre ...	2963	69	5260	94	2716	81
18. Green leaf + bonemeal to supply 20 lb. P_2O_5 per acre ...	2555	45	5260	94	2716	81
19. Green leaf + super to supply 10 lb. P_2O_5 per acre ...	2611	48	5777	114	2738	83
20. Green leaf + super to supply 20 lb. P_2O_5 per acre ...	2666	51	5000	85	3018	102

The combined effect of phosphates and different doses of green manure was more marked in such seasons, the increase being 41%, 67% and 87% over no manure plots. Even in normal seasons the combined effect of green leaf and phosphates over green leaf alone in the different treatments was marked in the case of straw yields. As in the case of grain yields,

green leaf with super-phosphate was more beneficial than green leaf with bonemeal. Between the different levels and forms of phosphoric acid there was no perceptible difference in straw yields.

(b) *Age of seedlings and time of planting*: At Anakapalle it was observed that seedlings whose ages ranged between 5 to 9 weeks did not show significant difference in yields in case of early and late varieties. In the case of season bound varieties like G. E. B. 24, it was noticed that seedlings aged 6 to 7 weeks were best suited for this locality. In this experiment G. E. B. 24 was planted and the ages of seedlings and yields of grain from manured and unmanured plots are furnished below:

Age of seedling	Yield of grain in lb. per acre		% increase over no manure
	Manured	Unmanured	
40 days	2927	2493	17
46 days	2905	2435	19
56 days	1788	1524	17
61 days	2202	1776	24
76 days	1661	1218	36

Forty to forty-six days old seedlings gave good yields. The results are in exact conformity with those recorded previously on this station.

(c) *Time of planting*: It was observed under Anakapalle conditions, that for medium duration varieties the effective tillering phase is between the 30th and 60th day after planting, provided that, the plants are normal, the seedlings are young and the post transplantation period is long. These are conducive for better crop performance as the results (1938 and 1940) in this experiment indicated. As mentioned already due to the absence of regular irrigation system, lack of assured water supply and because of the seasonal vicissitudes paddy plantings in this district are often delayed and at times uncertain. In this experiment the beneficial effects of manuring were felt more in the seasons when the post transplantation period till flowering was short. Results are furnished below:—

Year	Post transplantation period (from planting to flowering) in number of days	% increase in yield over no manure
1940	82	17%
1938	80	19%
1937	60	17%
1941	48	24%
1939	42	36%

In view of these results the advisability of green manuring paddy in this district cannot be over emphasised.

Economics: The economics of manuring are presented in table V. The indications were that (1) increased doses of green leaf enhanced the margin of profit which ranged between Rs. 10/- and Rs. 21/- for the five treatments but the increased profits over no manure recorded by treatments 8000 lb. and 6000 lb. per acre were practically similar. (2) application of phosphatic manures as benemeal and superphosphate alone at 10 lb. P_2O_5 and 20 lb. P_2O_5 per acre resulted in loss. From the above data the following inferences are drawn: (i) that application of P_2O_5 resulted in loss and (2) increased doses of green leaf varying from 4,000 lb. to 8,000 lb. enhanced the margin of profit.

The experiment could not be treated as a serial experiment since the error varied widely from season to season.

TABLE V

	Treatments			1937 — 38 to 1941 — 42 Average figures for 5 seasons		
	Green leaf (Sunn-hemp)	Bone meal	Super phosphate	Value of extra yield of paddy over no manure (control in one acre)	Cost of manuring one acre	Profit or loss incurred in manuring over one acre
1. Control	...	...	...	...	...	...
2.	...	10 lb. P_2O_5	...	2-3-0	1-3-5	3-6-5
3.	...	20 lb. P_2O_5	...	0-15-7	2-6-10	3-6-5
4.	...	...	10 lb. P_2O_5	1-11-1	2-0-7	3-11-8
5.	...	...	20 lb. P_2O_5	1-13-9	4-1-2	5-14-11
6.	4000 lb.	...	...	13-15-11	4-6-6	9-9-5
7.	4000 lb.	10	...	15-11-6	5-10-0	10-1-6
8.	4000 lb.	20	...	14-15-0	0-13-4	8-1-8
9.	4000 lb.	...	10	17-5-11	6-7-2	10-14-9
10.	4000 lb.	...	20	16-14-11	8-7-9	8-7-2
11.	6000 lb.	...	...	26-9-4	6-9-10	19-15-6
12.	6000 lb.	10	...	24-13-11	7-13-3	17-0-8
13.	6000 lb.	20	...	28-12-9	9-0-8	19-12-1
14.	6000 lb.	...	10	31-13-1	8-10-5	23-2-8
15.	6000 lb.	...	20	28-0-11	10-11-0	17-5-11
16.	8000 lb.	...	...	30-2-0	8-13-1	21-4-11
17.	8000 lb.	10	...	35-11-1	10-0-6	25-10-7
18.	8000 lb.	20	...	35-7-9	11-3-11	24-3-10
19.	8000 lb.	...	10	38-6-3	10-13-7	27-8-7
20.	8000 lb.	...	20	38-14-11	12-14-3	26-0-8

CONCLUSIONS

In order to determine the optimum quantity of green leaf manure (as sunnhemp) that is necessary for paddy and to assess the relative merits of phosphatic manures alone and in combination with green leaf, an experiment was laid out at the Agricultural Research Station, Anakapalle during 1937-38 and conducted for five successive years. The following conclusions are drawn from this experiment.

(1) Increased doses of green leaf upto 8000 lb. resulted in increased yields. However 6000 lb. seemed to be the economic limit.

(2) In adverse seasons when there was delayed planting increased yields due to green leaf manuring were more marked than in normal seasons.

(3) Application of phosphates alone in 10 and 20 lb. doses per acre as bonemeal or super phosphate has not increased the yields. But their combination with green leaf resulted in slightly increased grain yields. The effect of the combination was more beneficial on straw yields.

(4) Hence in districts like Vizagapatam which suffers from lack of assured water supply the adverse seasonal effects on grain yields can be minimised to a great extent by green leaf manuring

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