

Bonemeal versus Saphosphosphate as Fertilizer for Rice

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PRIOR to World War II (1939) the food requirements of Ceylon's growing population were met by a continuing annual increase in imports of foodstuffs which were easily and cheaply procured. The import of cheap rice in almost unlimited quantities depressed the income derivable from paddy cultivation to a point where little or no profit could be made. During this period paddy lands were generally never fertilized and not much attention was given to the improvement of methods of rice cultivation. If any fertilizers were used at all it was only bonemeal; and bonemeal, which could be stored for a number of years, was available for purchase at the local shops.

With the commencement of the war the situation underwent a complete change. The acute shortage of food throughout the period of the war made itself felt with particular severity in the Asian countries including Ceylon. From this time on there developed in Ceylon a new attitude to rice cultivation. No longer was it looked upon as the poor relation of the far more profitable plantation agriculture. There was a pressing need for increased local production of rice and a new importance was attached to rice cultivation.

Due to the paucity of knowledge of the use of fertilizers in rice cultivation as well as the prevailing scarcity of supplies of inorganic fertilizers arising from the disruption of navigation, the Ceylon Government made free issues of bonemeal to cultivators during the war and for a few years that immediately followed. Thus farmers grew accustomed to the use of bonemeal fertilizer as an integral part of the practice of rice cultivation.

It could also be argued that, during this period when the standards of rice cultivation were poor and the all-island average yield was as low as twenty bushels per acre, the necessity to replenish the soil with the nutrients removed by the crop would have arisen mainly with respect to phosphorus and this could have been satisfactorily achieved by the use of bonemeal. The crop removal of nitrogen appears to be restored to the soil by fixation of atmospheric nitrogen

by algae. The crop removal of potassium appears to be recuperated by the soil itself. When the water-soluble and exchangeable potassium are removed by the crop the unavailable forms of soil potassium are converted to exchangeable and water-soluble forms by natural processes. Thus there appears to have been a natural balance between crop removal and soil regeneration in respect of nitrogen and potassium. This may be the explanation of the fact that cultivation of rice on the same lands continued year in and year out for hundreds of years without exhausting the fertility of the soil.

In 1950, the Department of Agriculture, as a result of a series of fertilizer experiments, issued its recommendations of inorganic fertilizer mixtures, which were sold at prices subsidized by the government, and thereafter the free issue of bonemeal was withdrawn. There remained, however, some farmers who had grown so habituated to the use of bonemeal that they continued to use it. The majority of farmers who had acquired the knowledge of using inorganic fertilizers soon realised the greater economic benefit that could be derived from its use and quickly changed from bonemeal to artificial inorganic fertilizers. Nevertheless, as has been the common experience throughout the world the farming community as a body is generally conservative and tends to resist change even after the growth of knowledge has demonstrated its benefits.

Experiments conducted in several parts of the island in cultivators' fields by Ponnampurna (1958, 1960) revealed that there were no significant differences in yield resulting from the use of five different forms of phosphate, namely, rock phosphate (saphosphosphate), ordinary superphosphate, concentrated superphosphate, basic slag, and bonemeal. This confirms the view that, as flooding increases the availability of soil phosphorus mainly by chemical reduction of the sparingly soluble ferric phosphate to the more soluble ferrous phosphate and as applied phosphate fertilizer changes more quickly into iron phosphate in flooded soil than in upland soil, the particular form in which phosphate fertilizer is applied is relatively unimportant for flooded rice except in strongly acid soils where superphosphate may not perform as well as others and in near neutral and alkaline soils where rock phosphate may prove to be inferior. Arising from the findings of these experiments the use of bonemeal came to be discouraged since it was found to be more expensive than chemical fertilizers supplying the equivalent amount of phosphorus, and thus the least expensive form of phosphate, namely saphosphosphate, was recommended. At current prices one ton of saphosphosphate analysing 27.5 per cent. P_2O_5 sells at Rs. 292 while one ton of 3/32 inch grade bonemeal which analyses 22 per cent. P_2O_5 and 3 per cent. nitrogen costs Rs. 540.

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One disadvantage of saphosphosphate is its tendency to float in water thus causing it to drift with the wind and collect in certain parts of the field without being deposited at the points where it was intended to be applied. This is particularly so in fields that cannot be completely drained. Against this drawback of saphosphosphate, bonemeal had the advantage that it could be mixed with germinated seed and applied at the time when the seeds were broadcast, thus affecting a saving of labour as well.

Experiments conducted in the Maha season of 1963/64 to test the efficiency of bonemeal against saphosphosphate are reported below.

EXPERIMENTAL

Trial in Cultivators' Fields.

The experiment was planned and supervised by the Division of Agricultural Chemistry and executed by the extension staff with the co-operation of the cultivators. The trials were located in the peaty and marshy areas of the following four districts, Colombo, Kalutara, Galle and Ratnapura. In all there were 17 locations.

The design of the experiment was a randomised block containing six plots for the six treatments, the size of each plot being 30 feet by 14½ feet (one hundredth of an acre). At each location there was one such block of six plots. The extension officers were requested to consult their respective District Agricultural Officers and select fields representative of the area and a variety of rice best suited for the area. Of the 17 locations, improved varieties were used in 5, and local varieties were used in the remaining 12 (Table 1). The yield figures were statistically analysed after making the necessary correction of each plot yield for loss in weight on sun-drying.

Following were the six treatments tested at each location together with the cost of fertilizers:—

	<i>Before planting or sowing preferably at second ploughing</i>	<i>1st Top dressing</i>	<i>2nd Top dressing</i>	<i>Cost Rs. c.</i>
T ₁ Control ..	0	0	0	0
T ₂ ..	1 cwt. Saphosphosphate plus ½ cwt Muriate of potash per acre	½ cwt. Urea per acre	½ cwt. Urea per acre	53 03
T ₃ ..	1 cwt. Bone Meal 3/32,, grade per acre	0	0	27 0
T ₄ ..	2 cwt. Bone Meal 3/32,, grade per acre	0	0	54 0
T ₅ ..	140 lb. Bone Meal 3/32,, grade plus ½ cwt. Muriate of potash per acre	47 lbs Urea per acre	½ cwt. Urea per acre	69 17
T ₆ ..	2 cwt. Bone Meal 3/32,, grade plus ½ cwt Muriate of potash per acre	41 lbs. Urea per acre	½ cwt. Urea per acre	87 41

The first top-dressing was applied 2 weeks before heading and the second top-dressing at heading time.

Treatment 1 is the control and received no fertilizers. Treatment 2 is similar to the recommendation of the Department. Treatment 3 is 1 cwt. bonemeal per acre and treatment 4 is 2 cwt. bonemeal per acre. In treatment 5 the saphosphosphate in treatment 2 is replaced by bonemeal to give the same quantity of phosphorus. As bonemeal contains 3 per cent. nitrogen, this amount of nitrogen given in the form of bonemeal is reduced at the first top dressing of nitrogen. Thus treatments 2 and 5 are almost identical. In treatment 6, 2 cwt. of bone-meals plus dressings of nitrogen and potassium are given; the total quantity of nitrogen and potassium are the same in treatments 2, 5 and 6.

Trial at Rice Research Station, Bombuwela. A fertilizer trial was carried out in the peaty soils of the Bombuwela Rice Research Station in Maha 63/64 using 6 treatments almost similar to the 6 treatments used in cultivators' fields but with certain modifications. The general principles of selecting the 6 treatments were the same. The differences were in the times of application of potash and top-dressing of nitrogen. Potash was applied along with the first top-dressing of nitrogen which was at three weeks after transplanting. The second top-dressing of nitrogen was applied at one month before heading. The design of the experiment was a randomised block containing 6 plots and replicated four times. The variety of paddy used was H₁.

Following were the treatments :—

		<i>Before planting or sowing preferably at second ploughing</i>	<i>1st top dressing at 3 weeks from transplanting</i>	<i>2nd top dressing at 1 month before heading</i>	<i>Cost Rs. c.</i>
T ₁ Control ..	0	..	0 ..	0 ..	0
T ₂ ..	1 cwt. Saphosphosphate per acre	..	½ cwt. Urea plus ½ cwt. Muriate of potash per acre	½ cwt. Urea per acre	53 03
T ₃ ..	1 cwt. Bone Meal 3/32,, grade per acre	..	0 ..	0 ..	27 00
T ₄ ..	2 cwt. Bone Meal 3/32,, grade per acre	..	0 ..	0 ..	54 00
T ₅ ..	140 lbs. Bone Meal 3/32,, grade per acre	..	19 lbs Urea plus ½ cwt. Muriate of potash per acre	½ cwt. Urea per acre	69 17
T ₆ ..	2 cwt Bone Meal 3/32,, grade per acre	..	13 lbs Urea plus ½ cwt. Muriate of potash per acre	½ cwt. Urea per acre	87 41

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RESULTS AND DISCUSSION

Trials in Cultivators' Fields

In table 1 are given the yields of paddy of the different treatments, the varieties used in the different locations and the methods of planting. The yield figures were subjected to statistical analysis. The mean yields of the treatments in bushels per acre, the co-efficient of variation and the significant difference are given below.

T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	C of V	S.D. at 5%
33.8	42.3	36.0	38.9	40.2	40.7	11.5	3.04

The following inferences could be drawn from the results of this experiment :—

1. The fertilizer formulation of the Department (Treatment 2) appears to be the best.
2. Fertilizer formulation containing saphosphosphate and potash with top-dressings of nitrogen, and bonemeal and potash with top-dressings of nitrogen (treatments 2, 5 and 6) appear to be better than the control, 1 cwt. bonemeal only, and 2 cwt. bonemeal only per acre (treatments 1, 3 and 4).
3. There were no significant differences between saphosphosphate and potash with top-dressings of nitrogen (treatments 2, 5 and 6). This indicates that there is no necessity for replacing saphosphosphate with the more expensive bonemeal and the use of bonemeal should be discouraged on economic considerations.

Trial at Rice Research Station, Bombuwela

The yields of paddy of the different treatments are given below :—

Plot Yields of Paddy in lbs.

	R ₁	R ₂	R ₃	R ₄
T ₁	10.58	11.22	10.36	12.29
T ₂	15.40	13.62	10.42	13.25
T ₃	12.15	9.33	8.77	12.31
T ₄	10.83	8.64	9.66	13.28
T ₅	13.58	12.59	13.56	13.48
T ₆	14.40	13.40	11.86	12.24

The yield figures were statistically analysed. The mean yields of the treatments in bushels per acre, the coefficient of variation and the significant difference are given below.

T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	C of V	S. D. at 5%
49.3	58.5	47.2	47.1	59.1	57.6	10.4	8.34

The following inferences could be drawn from the results of this experiment :—

1. Fertilizer formulation containing saphosphosphate and potash with top-dressings of nitrogen, and bonemeal and potash with top-dressings of nitrogen (treatments 2, 5 and 6) were significantly better than the control, 1 cwt. bonemeal only and 2 cwt. bonemeal only per acre (treatments 1, 3 and 4).
2. There were no significant differences between the control, 1 cwt. bonemeal only per acre and 2 cwt. bonemeal only per acre (treatments 1, 3 and 4).
3. There were no significant differences between saphosphosphate and potash with top-dressings of nitrogen, and bonemeal and potash with top-dressings of nitrogen (treatments 2, 5 and 6). This indicates, as in the trials in cultivators' fields, that there is no necessity for replacing saphosphosphate with the more expensive bonemeal.

SUMMARY

Fertilizer trials were carried out during Maha 1963-64 in the peaty and marshy soils at 17 locations in cultivators' fields of Colombo, Kalutara, Galle and Ratnapura Districts to test the efficiency of bonemeal against an inorganic fertilizer formulation containing saphosphosphate. A trial was also conducted at the Rice Research Station, Bombuwela.

The treatments tested were :—

1. Control.
2. 1 cwt. saphosphosphate plus $\frac{1}{2}$ cwt. Muriate of potash per acre plus top-dressings of nitrogen.
3. 1 cwt. Bonemeal per acre.
4. 2 cwt. Bonemeal per acre.
5. Same as treatment 2 but the saphosphosphate is replaced by bonemeal to give the same quantity of phosphoric acid.
6. 2 cwt. Bonemeal plus $\frac{1}{2}$ cwt. Muriate of potash per acre plus top-dressings of nitrogen.

Treatments 2 and 5 contain equal quantities of nitrogen, phosphorus and potassium.

Treatments 2, 5 and 6 contain equal quantities of nitrogen and potassium.

The inferences that could be drawn from these experiments are :—

1. Fertilizer formulations containing saphosphosphate and potash with top-dressings of nitrogen, and bonemeal and potash with top-dressings of nitrogen (Treatments 2, 5 and 6) were better than the control, 1 cwt. bonemeal per acre and 2 cwt. bonemeal per acre (Treatments 1, 3 and 4).
2. There was no significant difference between saphosphosphate and potash with top-dressings of nitrogen, and bonemeal and potash with top-dressings of nitrogen (Treatments 2, 5 and 6). This indicates that there is no necessity for replacing saphosphosphate with the more expensive bonemeal and therefore the use of bonemeal should be discouraged on economic considerations.

LITERATURE CITED

- PONNAMPERUMA, F. N., 1958—Fertilizer Trials in Cultivators' Fields in Ceylon, *Tropical Agriculturist*, Vol. CXIV, 245-254.
- PONNAMPERUMA, F. N., 1960—Fertilizer Experiments in Cultivators' Fields in Ceylon, *Tropical Agriculturist*, Vol. CXVI, 253-267.

Table 1.—Bonemeal Trials—Cultivators' Fields—Maha 63-64

District	Range	Location	Variety	Method of Planting	Plot Yields in lbs.					
					Control	Departmental Recommendation	1 cwt. bone meal per acre	2 cwt. bone meal per acre	Sapthosphos phosphate of the Dep. recom- replaced by bone meal	2 cwt. bone meal plus top dressings of nitrogen
					T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Kalutara	Kalutara	Panwila	H4	Broadcast	15.3	24.7	16.4	25.1	26.4	18.2
	Matugama	Walallawita	Batapolawi	Broadcast	16.7	18.9	19.0	19.3	18.4	18.6
	Panadura	Morontoduwa	Ratuwi	Broadcast	11.6	18.4	14.5	17.4	18.3	18.5
	Bulathsinghala	Selladeniya	Madael	Broadcast	10.7	11.9	11.0	13.6	11.9	12.2
	Bulathsinghala	Alubogaha	Hondarawala	Broadcast	13.7	15.1	14.5	14.0	12.9	14.8
Galle	Talpe Pattuwa West	Yakkalamulla	61-555 selection	Row Sown	19.4	19.6	15.7	18.1	16.3	20.6
	Galle	Uluwitike	Sulai	Row Sown	15.0	15.2	14.8	15.3	15.2	15.3
	Elpitiya	Ihala Elpitiya	Batapolawi	Row Sown	17.9	24.5	18.1	20.5	22.3	23.7
Ratnapura	Nawadun Korale West	Ellapatha	Hondarawala	Broadcast	8.8	13.6	11.5	14.2	13.9	12.7
	Parakaduwa	Kuruwita	H4	Row Sown	10.6	23.1	17.9	19.1	21.2	22.8
	Meda Korale	Balangoda	M 302	Broadcast	18.1	18.8	14.8	17.4	18.7	16.7
	Nawadun Korale East	Niwitigala	Suduwi	Trans-planted	11.8	18.5	15.5	17.7	17.3	19.2
	Homagama	Panagoda	H4	Trans-planted	20.7	21.6	20.2	16.7	21.6	22.2
Colombo	Kosgama	Balladeniya	Suduwi	Broadcast	17.6	21.4	20.9	19.9	20.4	18.9
	Kosgama	Kahatakumbura	Kahatawi	Broadcast	18.1	20.0	18.6	19.8	18.4	18.3
	Piliyandala	Piliyandala	Sulai	Broadcast	16.0	18.4	17.9	14.0	19.4	20.7
	Piliyandala	Polgasowita	Suduwi	Broadcast	16.6	20.0	13.9	15.6	14.8	17.3