
EFFECT OF THE FORM OF NITROGEN FERTILIZER ON THE YIELD OF RICE

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AMMONIUM sulphate as a nitrogen fertilizer for paddy has been found unsuitable in certain localities (1, 2, 3, 4): the application of 100 lb. N/acre in the form of ammonium sulphate gave yield increases of only 7-10 bushels per acre on ill-drained soils; these poor responses have been attributed to the toxic effects of hydrogen sulphide generated by the sulphur in the fertilizer. For these soils therefore a nitrogen fertilizer without sulphur, such as calcium cyanamide or urea, is indicated.

This paper summarizes the results of a trial conducted at Maha Illuppallama, to test the relative merits of ammonium sulphate and calcium cyanamide under dry-zone conditions.

EXPERIMENTAL DESIGN

The 13 treatments which included two forms of nitrogen fertilizers, viz., ammonium sulphate and calcium cyanamide, applied at 40 lb. N/acre, two times of application, three methods of placement and an untreated control (Table 1), were replicated in four randomized blocks. The variety used was Murungakayan 302, transplanted in plots 10' × 29' at 6" × 12". In addition to the nitrogen fertilizers all plots received a basal dressing of 20 lb. per acre P_2O_5 and 10 lb. per acre K_2O at planting. The trial was conducted over four seasons; *Maha* 1953/54, *Yala* 1954, *Maha* 1954/55 and *Maha* 1955/56.

The soil in the trial fields is a light, sandy loam with a pH of about 7.0 and a redox potential of about +200 m.v. before flooding dropping to -10 m.v. within a fortnight of flooding and rising to +50 to +100 m.v (5).

RESULTS AND DISCUSSION

Results are summarized in Table 2, 3 and 4.

The general trend of the results clearly demonstrates that ammonium sulphate is greatly superior to calcium cyanamide as a nitrogen fertilizer for fields such as are found in Maha Illuppallama, the former giving as much as $3\frac{1}{2}$ bushels of paddy per acre more than the latter (Table 3). Compared with the untreated control, however, both fertilizers gave significant increases in yield: the lower yields obtained with calcium cyanamide may possibly be attributed, in part at least, to the effects of toxic intermediates such as dicyandiamide produced in the course of its decomposition in the soil.

The results also show (Table 3) that the time and method of application of the fertilizer is as important, if not more so, than the kind of fertilizer itself. Applying nitrogen during preparation of the field, i.e., two weeks before transplanting, is definitely less advantageous than applications two weeks after the crop has been planted, there being a difference of about 5 bushels per acre between the two times of application.

But the greatest increases in yield are obtained by the method of placement of the fertilizer. The highest yields are obtained by sub-surface application. Compared with the control, fertilizer applied at the surface gives an increase in yield of only about 7 bushels/acre (Table 3).

But the effect of time of application and method of placement of fertilizer show a significant interaction (Table 4). Other interactions as between kind of fertilizer and time of application and kind of fertilizer and method of placement were not significant. The interaction between time of application and method of placement of nitrogenous fertilizer shows that when a nitrogenous fertilizer is applied to the surface of the soil, it matters very little whether the application is performed either before or after sowing. In fact the difference between ammonium sulphate and calcium cyanamide applied as a surface dressing either before or after planting is only about $\frac{1}{2}$ —2 bushels/acre. It could thus be said that, while sub-surface application is better than surface application of a nitrogenous fertilizer, and while it is better to apply it after planting rather than before planting the greatest benefits accrue only by employing both methods in combination.

Sub-surface applications of ammonium sulphate give higher yields than surface application because the reduced conditions in the sub-surface zones prevent the oxidation of ammonium nitrogen into nitrate nitrogen. On the other hand, ammonium sulphate applied as a

surface dressing is subjected to rapid oxidation ; the nitrate nitrogen thus formed is leached downwards and undergoes denitrification to ultimately escape as free nitrogen without benefit to the crop. Redox potential studies (5) show a rapid intensification of this process as the crop matures, which may perhaps be the reason for the greater responses obtained by sub-surface applications after planting rather than by sub-surface applications before planting.

While in the case of grain yield, the highest responses were generally obtained with deep placement, i.e., 6"—8" below the surface the highest straw yields, with one exception, were obtained with shallow placements, i.e., 1"—2" below the surface. The phenomenon is difficult to explain on the basis of the data available and hence will not be discussed.

The chaff percentage too shows a variation from the general trend in grain weight. Ammonium sulphate gives more chaff than calcium cyanamide and generally, higher grain weights correspond to a higher chaff content.

CONCLUSION

It can be generally stated that for dry-zone soils as characterised by those found in Maha Illuppalama, ammonium sulphate is to be preferred as a nitrogen fertilizer. Greatest benefits from its use, however, depend upon the method of application. While generally speaking, application after transplanting is better than application before planting, and while sub-surface application is better than surface application, the significant interaction shows that it is the combination of both methods which contribute to the greatest yield.

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REFERENCES

1. Administrative Report of the Director of Agriculture, Ceylon, 1952.
2. Administrative Report of the Director of Agriculture, Ceylon, 1955.
3. Administrative Report of the Director of Agriculture, Ceylon, 1956.
4. Administrative Report of the Director of Agriculture, Ceylon, 1957.
5. Oxidation—Reduction potentials in Rice Soils—Trends in a Dry Zone Yield—C. R. Panabokke, *Tropical Agriculturist*, Vol. CIX 1953 : 287-294.

Table 1—Treatments

Plot	Fertilizer	Time of Application	Dept. of Placement	Remarks
1 ..	Control	.. —	.. —	(1) Time of application— T ₁ Two weeks before transplanting
2 ..	—	.. —	.. P ₁	
3 ..	—	.. T ₁	..	
4 ..	Ammonium	.. —	.. P ₃	(2) Depth of placement— P ₁ Deep : 6"–8" below surface
5 ..	Sulphate N ₁	.. —	.. P ₁	P ₂ Shallow : 1"–2" below surface P ₃ Surface
6 ..	—	.. T ₂	.. P ₂	
7 ..	—	.. —	.. P ₃	(3) Both N—Fertilizer applied at the rate of 40 lb. N/acre
8 ..	—	.. —	.. P ₁	
9 ..	—	.. T ₁	.. P ₂	(4) All plots received a basal dressing of 20 lb./P ₂ O ₅ + 10lb./acre K ₂ O
10 ..	Calcium midide Cyana-	.. —	.. P ₃	
11 ..	—	.. —	.. P ₁	
12 ..	N ₂	.. T ₂	.. P ₂	
13 ..	—	.. —	.. P ₃	

Table 2—Yield of Grain and Straw

Treatments	Grain lb./Ac.	Grain per Cent. of Control	Straw lb./Ac.	Total Dry Weight
Control ..	2632.9	100.00	3949.3	6582.2
Ammonium Sulphate				
T ₁ { P ₁	3312.9	125.82	4856.9	8369.8
{ P ₂	3213.2	122.04	4320.4	7533.6
{ P ₃	2944.7	111.84	4471.7	7416.4
T ₂ { P ₁	3673.7	139.53	4891.2	8564.9
{ P ₂	3732.5	141.76	5270.4	9002.9
{ P ₃	3011.9	114.39	4748.4	7760.3
Calcium Cyanamide				
T ₁ { P ₁	3191.2	121.20	4421.3	7612.5
{ P ₂	3080	117.01	4598.8	7679.6
{ P ₃	2918.7	110.85	4112.7	7031.4
T ₂ { P ₁	3509.6	133.29	4806.5	8316.1
{ P ₂	3342.5	126.95	4901.3	8243.6
{ P ₃	2930.9	111.31	4538.2	7469.1
SE ..	63.53	2.41		

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Table 3—Yield of Grain and Straw (individual treatment)

<i>Treatment</i>	<i>Grain lb./Ac.</i>	<i>Straw lb./Ac.</i>	<i>Total Dry Weight</i>
Fertilizer			
Ammonium Sulphate	3314.8	4760.1	8074.9
Calcium Cyanamide	3162.3	4840.8	8003.1
S. E.	25.94		
Time of application			
Two weeks before transplanting	3110.3	4457.6	7567.9
Two weeks after transplanting	3366.9	4861.0	8227.9
S. E.	25.94		
Depth of placement			
Deep	3421.8	4740.0	8161.8
Shallow	3342.3	4760.1	8102.4
Surface	2951.6	4457.6	7409.2
S. E.	31.76		

Table 4—Grain Yield Interaction

TIME OF APPLICATION × DEPTH OF PLACEMENT

<i>Depth of Placement</i>	<i>Time of Application</i>	
	<i>2 Weeks before transplanting</i>	<i>2 Weeks after transplanting</i>
Deep	3252.0 lb./ac.	3591.7 lb./ac.
Shallow	3146.9 "	3537.6 "
Surface	2931.7 "	2971.5 "
S. E.	44.94 lb./ac.	