DECOMPOSITION OF OIL-CAKES AND FORMATION OF NITRATE.

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(*Read at Symposium, August 29-30, 1936.*)

Oil-cakes are valuable organic manures. They are in common use in Bengal for crops like potato, tobacco, sugar-cane, betel-vine, etc. They are applied in the *rabi* season for potato and tobacco and for sugar-cane and betel-vine in the *kharif*. The usual method of application is in the trenches or in the field at the time of the preparation of the soil and later on as a top dressing once or more according to the nature of the crop. In some places they are applied after preliminary rotting sets in by keeping the cakes mixed with earth in a pit and moistening the same with water.

It is a matter of common knowledge that oil-cakes take time to disintegrate and to become useful as plant food but nothing definite can be said on the point. The importance lies in the time of applying the cake to a quick growing crop ; if applied too early or too late there may be economic wastage, which is bad farming. In order to see how far the cultural practice followed in Bengal is suitable, i.e. how far the period of plant growth agrees or synchronises with the time of vigorous plant food formation (nitrate), and to find out the best time of application of the cake, an investigation was undertaken to study the decomposition of oil-cakes in the pot-culture house.

Eight tins each containing 30 lbs. of Dacca red soil have been taken. These tins have been coated inside and outside with a paint of tar. The scheme of the treatment is given below :—

(1) Soil only.
(2) Soil and lime.
(3) Soil and lime and castor cake (50 gms.).
(4) Soil and lime and groundnut cake (quantity of cake as in No. 3).
(5) Soil and lime and groundnut cake (mgms. N_2 as in No. 3).
(6) Soil and castor cake (quantity as in No. 3).
(7) Soil and groundnut cake (quantity as in No. 3).
(8) Soil and groundnut cake (quantity as in No. 5).

Soil taken .. 30 lbs.

Lime applied .. 25 gms.
(Nos. 2, 3, 4, and 5).

Castor cake .. 50 gms. to supply 18·2 mgms. N_2 per 100 gms. dry soil.
(Nos. 3 and 6).

Groundnut cake (Nos. 4 and 7) .. 50 gms. to supply 32·6 mgms. N_2 per 100 gms. dry soil.

Groundnut cake (Nos. 5 and 8) .. 28·2 gms. to supply 18·2 mgms. N_2 per 100 gms. dry soil.

Percentage of nitrogen { (*a*) Castor cake.....4·40. (*b*) Groundnut cake..7·80.

All these tins have been kept inside the pot-culture house and the moisture content of the soil has been kept at about 18% by periodical addition of water. The soil in the tins has been sampled by an improvised auger from time to time and analysed for *nitrate* by the phenol-sulphonic acid method. The experiment continued from mid August to the 1st week of December.

TABLE I.

Amount of nitrogen (mgms.) nitrate per 100 gms. dry soil.

Period of analysis	Treatment (1)	Treatment (2)	Treatment (3)	Treatment (4)	Treatment (5)	Treatment (6)	Treatment (7)	Treatment (8)
25th–28th August ..	5·55	5·09	3·65	3·84	5·65	5·25	3·37	3·94
1st–4th September ..	5·19	4·81	0·69	0·26	4·40	4·52	3·60	4·14
8th–11th September	4·90	5·20	0·69	*nil*	5·21	6·15	5·41	5·84
15th–18th September	4·39	5·86	0·90	*nil*	6·67	6·93	6·23	5·82
22nd–26th September	5·53	7·06	1·34	0·29	7·12	6·72	5·83	5·84
21st–24th October ..	5·45	7·95	4·96	9·73	8·89	6·62	8·00	6·87
3rd–6th November ..	4·51	7·48	8·53	19·39	7·90	6·05	6·60	6·91
10th–13th November	5·01	9·00	14·01	25·40	12·37	7·58	9·26	8·43
17th–20th November	6·30	11·42	17·45	29·65	15·22	8·60	12·68	9·85
24th–27th November	6·52	11·44	18·98	30·93	16·84	10·13	13·84	9·89
1st–4th December ..	6·44	11·61	18·99	31·18	17·49	9·90	13·81	9·91
Percentage of added nitrogen nitrated per 100 gms. dry soil (allowance being made for the nitrate in the soil with and without lime).			40·54	60·03	32·30	19·01	22·60	19·06

The analytical data are given in Table I and plotted in Graph 1. An examination of the figures shows that the addition of the cake causes at the start a slight depression in nitrification which lasts for a short time. The formation of nitrate, however, progresses gradually afterwards. The effect of preliminary depression and formation of nitrate afterwards is more pronounced when lime is added with the cake. The depression lasts for a longer time and is greater the larger the quantity of cake applied. During this period the nitrate concentration is reduced to a minimum. When the depression is over, a rapid rise in nitrification occurs. Lime intensifies nitrification. Thus, there is more accumulation of nitrate in the soil treated with lime than that in the untreated soil. With castor cake, the maximum percentage of added nitrogen nitrated during the course of the investigation has been roughly 19 as

against 40 with lime. Similarly, with groundnut cake (higher dose) the maximum percentage has been roughly 22 without lime and 60 with lime, and with the lower dose the corresponding figures are roughly 19 and 32 respectively. Of the two cakes, castor and groundnut, when equal amounts of nitrogen have been added nitrification is almost similar in both (about 19%) when applied without lime, but with lime castor cake does better than groundnut (40% as against 32%).

Regarding the depression in nitrification when cake is added to the soil it is first decomposed into nitrogenous and carbonaceous compounds. The latter in course of its further oxidation readily takes up oxygen from the air and the soil, while the nitrogenous compounds remain starved to a certain extent and nitrification makes headway only when the former reaction slows down. With lime, the decomposition of cake takes place more rapidly, resulting in the greater utilisation of available oxygen, and this probably explains the greater depression in nitrification at the early stage.

In order to follow the effect of nitrification on crops another series of experiments were started later on. The technique of the experiment has been the same as before, the only difference being that groundnut cake has been replaced by mustard cake and that two more similar series have been added. These two series have been sown with jute seeds and one of the series has been kept in the pot-culture house, while the other series has been kept outside. The tins in the latter series have been pierced with holes at the bottom to allow percolation and they have all been embedded in the field to approximate field conditions. The work began on the 25th May and lasted till the middle of September.

Nitrate formation has been studied periodically as before in all the three series of pots. The analytical figures are given in Table II.

Nitrification has followed a more or less parallel course as before. Here, too, lime has depressed nitrification at the start and later on has intensified it. It may be noted that in a few cases abnormal nitrification has been observed. This may be attributed to defective mixing of the cake with the soil and to error in sampling.

The next point of interest is the effect of cake on the jute crop. On comparing the two series of pots, one inside and the other outside the pot culture house, it has been observed that the plants in the inside pots died before they were barely 2″ to 3″ high, except in 3 pots, where they had a precarious existence, the maximum height being about 4″, while the plants in the outside pots had a normal growth. On examination of the nitrate figures it is seen that the concentration of nitrate had been very high in the inside pots. About the middle of July, when the inside plants were only 2″ and were decaying, the outside plants were healthy and making normal growth. The concentration of nitrate was of the order 10-15 in the inside pots as against 2 to 6 outside. The failure of plants inside may be attributed to the high concentration of nitrate, which the plants could not stand, while outside the

TABLE II.

Nitrogen nitrated per 100 *gms. of dry soil* (*in milligrams*)

		May 27	June 5	June 22	June 30	July 8	July 23	August 5	Sept. 2	Sept. 15
		Date of analysis								
1. Treatment (1)	Kept inside the pot culture house.	4·88	6·90	8·84	8·38	9·67	10·85	11·41	13·40	11·67
2. Do. (2)		2·85	6·68	7·00	7·55	7·89	10·72	13·06	21·57	11·57
3. Do. (3)		5·82	7·37	7·25	7·97	8·41	9·19	16·61	18·40	14·62
4. Do. (4)		2·38	5·14	15·89	21·48	19·02	31·78	34·96	36·88	27·30
5. Do. (5)		6·18	10·01	7·41	6·85	9·92	10·28	13·14	17·19	18·36
6. Do. (6)		2·86	5·16	12·73	14·43	15·24	18·34	34·78	56·81	31·70
7. Do. (7)		3·71	9·60	7·95	9·41	12·54	16·19	18·90	46·38	37·93
8. Do. (8)		2·36	5·06	12·03	15·66	18·34	29·35	23·25	26·35	30·34
9. Same as (1)		5·27	4·79	4·11	5·48	6·59	8·59	7·39	8·00	....
10. Do. (2)		4·74	5·70	7·72	8·02	10·43	10·73	10·82	10·34	....
11. Do. (3)		8·38	4·79	8·06	11·74	9·30	14·86	17·08	13·23	....
12. Do. (4)		3·63	4·33	15·02	23·98	25·74	31·24	35·64	29·10	....
13. Do. (5)		7·51	6·06	7·28	9·44	7·32	13·14	23·26	12·35	....
14. Do. (6)		2·55	3·65	10·98	12·37	15·27	18·16	16·44	17·42	....
15. Do. (7)		14·32	7·67	7·51	11·06	9·31	12·05	14·63	27·02	....
16. Do. (8)		2·31	3·04	14·59	20·87	16·62	23·63	18·23	19·04	....
17. Do. (1)	Kept in the field.	4·32	3·81	0·95	1·37	1·99	1·05	0·62	*nil*	*nil*
18. Do. (2)		5·33	4·70	0·97	0·86	0·79	*nil*	0·35	*nil*	*nil*
19. Do. (3)		6·18	6·29	5·57	....	5·95	5·15	6·92	1·07	*nil*
20. Do. (4)		3·92	3·61	4·83	5·22	6·43	0·79	*nil*	*nil*	*nil*
21. Do. (5)		6·81	8·26	2·45	0·86	6·00	3·19	4·37	*nil*	*nil*
22. Do. (6)		4·34	4·87	4·59	3·72	5·40	3·35	1·09	*nil*	*nil*
23. Do. (7)		10·79	7·90	....	3·52	7·77	5·18	4·60	3·17	*nil*
24. Do. (8)		4·14	3·14	....	3·45	4·69	0·96	*nil*	*nil*	*nil*
Rainfall between successive analysis in inches.		..	..	3·87	7·03	1·22	7·37	1·32	7·94	3·03

Note.—Treatment (1), (9), and (17)—Soil only (30 lbs.).

Treatment (2), (10), and (18)—Soil (30 lbs.)+Lime (25 gms.).

Treatment (3), (11), and (19)—Soil (30 lbs.)+Castor Cake (55 gms.) equivalent to 30 mgms. N_2 per 100 gms. dry soil.

Treatment (4), (12), and (20)—Soil (30 lbs.)+Castor Cake (55 gms.) equivalent to 30 mgms. N_2 per 100 gms. dry soil+Lime (25 gms.).

Treatment (5), (13), and (21)—Soil (30 lbs.)+Mustard Cake 55 gms. (20 mgms. N_2).

Treatment (6), (14), and (22)—Soil (30 lbs.)+Lime (25 gms.)+Mustard Cake (small dose) 55 gms. (20 mgms. N_2).

Treatment (7), (15), and (23)—Soil (30 lbs.)+Mustard Cake (big dose) 82 gms. (30 mgms. N_2).

Treatment (8), (16), and (24)—Soil (30 lbs.)+Lime (25 gms.)+Mustard Cake (big dose) 82 gms. (30 mgms. N_2).

Remarks.—Pots 9 to 16 have been sown with jute and kept inside the pot-culture house.

Pots 17 to 24 have been similarly sown with jute but kept outside the pot-culture house and embedded in the field.

nitrate formed was mostly washed off by the rains and the residual nitrates were sufficient for the growth of the plants. It may be noted that the limed pots recorded higher yields than the unlimed ones. Another point to be noted is that with cake nitrification commences vigorously 6 to 8 weeks after its application and the nitrate goes on accumulating until the heavy rains of the monsoon wash off most of the nitrate. This is an economical loss of great significance. From a practical standpoint the application of cake should be so made as to enable the crop to utilise the nitrate as much as possible before it is washed off. This points to the advisability of the application of cake during the *rabi* season so that the *kharif* crop, following a *rabi* crop, may derive the maximum benefit of the nitrate which remains unutilised by the *rabi* crop, and which is formed afresh by the further decomposition of the cake. In no case should the cake be applied in the *kharif* season for quick growing crops, as in that case there is the great risk of loss of a considerable portion of the nitrate made available by the further decomposition of the cake.

The present practice of applying cake in the *rabi* season for potato seems to be a sound one as the succeeding crop, usually jute, can fully utilise the unspent and freshly formed nitrate. As mentioned before cake is applied in the *kharif* season for crops like sugar-cane and betel-vine. Of these, betel-vine is a perennial crop while sugar-cane is almost a full year crop. The application of cake in the *kharif* season no doubt involves a great risk of loss of nitrate, but the well-established root systems enable sugar-cane and betel-vine to utilise the nitrate as soon as it is formed. So the loss of nitrate by washing during the rains is minimised to a great extent.

Summary

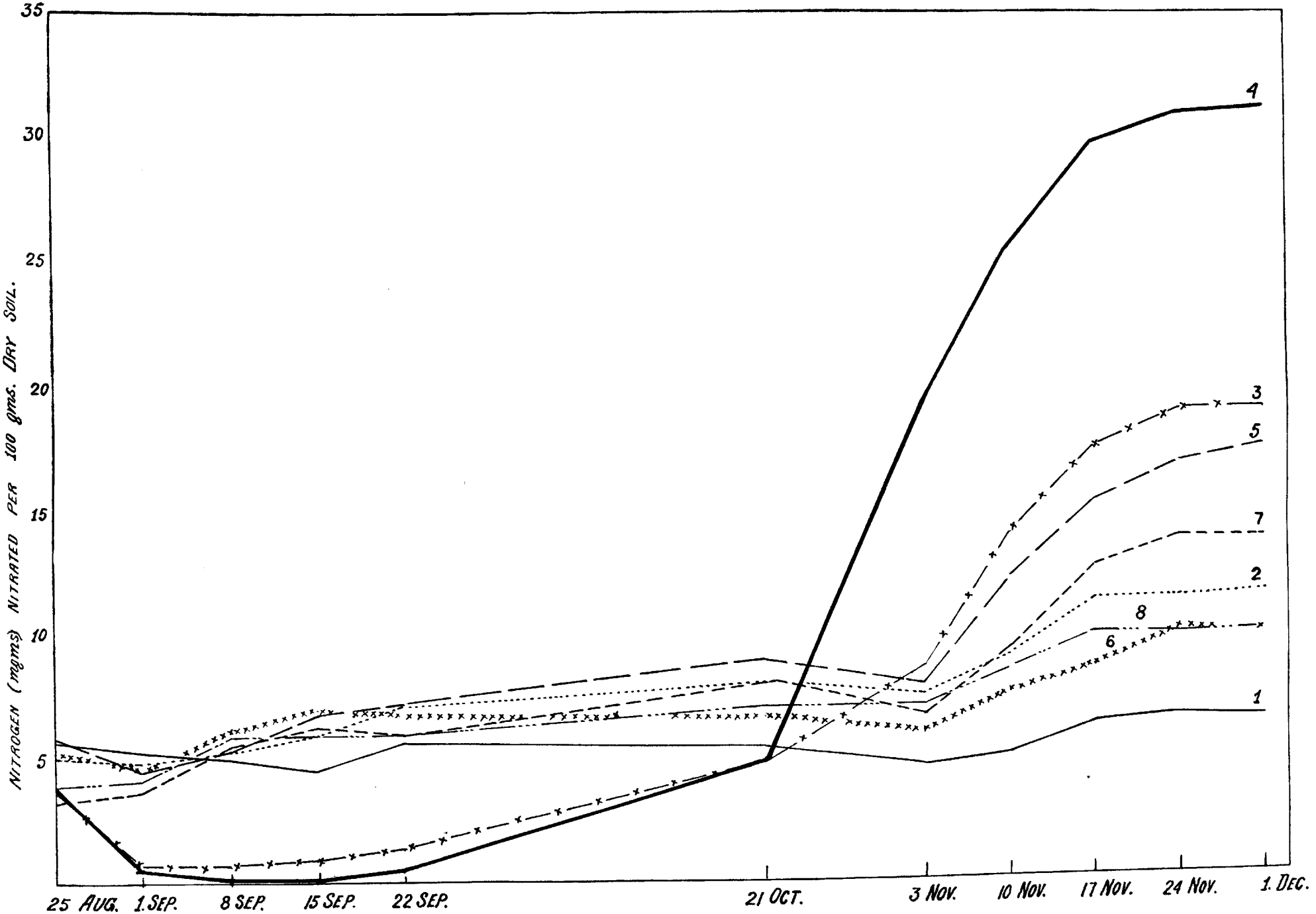
The decomposition of 3 kinds of oil-cakes in soil with and without lime and the formation of nitrate therefrom has been studied.

After a preliminary depression lasting for a short time nitrification goes on vigorously. Addition of lime quickens the decomposition of the cake and intensifies the nitrification.

The influence of nitrate on jute has been studied in pots. High concentration of nitrate in soil has been found to inhibit the growth and ultimately to result in the total failure of jute.

The heavy rains during the monsoon wash off most of the nitrates from the soil and hence the application of cake in the *kharif* season precludes the possibility of deriving maximum benefit. The present practice of the application of cake as a manure has been discussed. The application of cake during the *rabi* season appears to be more sound.

GRAPH 1.


Mg. ms.
35
30
25
20
15
10
5
NITROGEN (mgms) NITRATED PER 100 gms. DRY SOIL.
4
3
5
7
2
8
6
1
25 AUG.
1. SEP.
8 SEP.
15 SEP.
22 SEP.
21 OCT.
3 NOV.
10 NOV.
17 NOV.
24 NOV.
1. DEC.