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THE MINERALISATION OF NITROGEN FROM NON-EDIBLE OIL CAKES IN MEDIUM BLACK CALCAREOUS AND LATERIT1C SOILS

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Organic materials have a vital role in the production of a fertile soil. Of the various organic materials, oil cakes occupy a prominent position and are classified under the concentrated organic manure. Edible oil cakes are commonly used as manure in India. But it will be desirable to release these protein resources for animal consumption and look for alternative sources for plant nutrition. Non-edible oil cakes have thus received prominence when efforts were directed towards manufacture of vegetable oils. Oils of some of the non-edible oil seeds have proved to be useful in oil industry. Thus the possibilities of getting the non-edible oil cakes as by-products on commercial scale are becoming clearer. A large quantity of different non-edible oil seeds would be available if all the resources in the forest and other areas are utilised. Practically very little work has been done on many of non-edible oil cakes available and hence an investigation was undertaken to study the comparative manurial value of six non-edible oil cakes in respect of mineralisation in two typical soils of Maharashtra, India.

Materials and Methods

Two typical soils of Maharashtra, the medium black calcareous soil from the Agricultural College, Poona and the lateritic soil from the Agricultural College. Dapoli from a depth of 0-30 cm were collected. Th3 physico-chemical properties of these soils were determined using standard methods as described by Wright (1934), AOAC (1950), Piper (1942) and Jackson (1958).

The six non-edible oil cakes. viz., neem (*Azadirachta indica*), karanja (*Pongamia glabra),* castor (*Ricinus communis*), pilu (*Salvodora cleoides)* kusum (*Actinodaphane hookerii*) and pisa (*Scheloichera triguga*) cake were used in study. The oil from the cakes was further extracted with solvent ether in a soxhelet apparatus and the percentage of oil determined. The composition of the cakes used was determined using standard methods.

For the study of mineralisation of nitrogen from non-edible cakes, two set of Erlenmeyer flasks of 500 ml capacity were arranged for each type of soil. Each flask containing 100 g soils was treated with the calculated quantity of finely powdered cake to supply 100 mg of nitrogen per 100 g soil. After mixing well, the soils were brought to moisture equivalent by adding calculated quantities of distilled water. This moisture level was maintained through out the period of 60 days by periodical additions of calculated quantities of distilled water.

The release of ammoniacal and nitrate nitrogen was studied at seven occasions during the course of 60 days at an interval of 10 days. Each of the sets for each soil consisted of seven treatments, which were *replicated* seven times with each replicate in duplicate. Sampling was done at 0, 10, 20, 30, 40, 50 and 60th day, each time taking one replicate in duplicate. The entire content of the flask was used for the determination of ammoniacai and nitrate nitrogen, Details of the treatment in each of the two sets of flasks containing the two different soils are 1) Control 2) Soil + neem cake 3) Soil + karanja cake 4) Soil + pilu cake 5) Soil + kusum cake 6) Soil + pisa cake 7) Soil + castor cake.

Table 1

Physico-chemical properties of the soils

	Medium black calcareoussoil	Lateritic soil
Air dry moisture, %	8.21	5.15
Moisture equivalent, %	32.15	27.00
Maximum water holding capacity, %	60.00	40.00
Coarse sand, %	4.76	5.15
Fine sand, %	20.46	22.21
Silt, %	29.66	19.15
Clay, %	31.67	44.36
Textural classification	Clay loam	Clay loam
Calcium carbonate, %	12.19	—
Organic matter, %	1.26	2.64
HCl insoluble matter, %	64.72	53.15
Sesquioxides, %	16.77	32.01
HCl soluble CaO, %	7.65	0.54
HCl soluble MgO, %	3.33	0.05
HCl soluble [illegible] %	0.15	0.08
HCl soluble K_2O, %	0.24	0.09
Total nitrogen, %	0.06	0.15
Organic carbon, %	0.64	1.53
C/N ratio	9.68	10.13
Available P_2O_5, ppm	82.00	82.00
Available K_2O, ppm	62.00	46.00
Exch. Ca, me/1 00 g	65.73	6.99
Exch. Mg, me/1 00 g	5.25	2.52
Exch. Na + K, me/100 g	2.41	1.27
Total exch. bases, me/1 00 g	73.39	16.75
pH (1 : 2.5)	7.2	5.6
TSS, mmho/cm	0.064	—

Results and Discussion

It is se3n from Table 1 that, both tha medium black calcareous soil and lateritic soil were clay loam in texture. Medium black calcareous soil contained large amouts of free calcium carbonate whereas in lateritic it was completely absent. In calcareous soil organic matter content was low. Lateritic soil contained a high amount of organic matter. The medium black calcareous soil was well supplied with nitrogen, available phosphorus and potash but the lateritic soil though well supplied with nitrogen was low in available phosphorus and potossium. Medium black calcareous soil was base saturated, calcium forming about 90 per cent of tha total exchangeable bases and the soil reaction being on the alkaline side. But in lateritic soil, base status was low and contained large amounts of exchangeable hydrogen as could be revealed from tha distinctly acidic reaction.

Table 2

Composition of non-edible oil cakes, per cent

Name	Neem	Karanja	Castor	Pilu	Kusum	Pisa
Moisture	5.00	4.52	4.60	6.50	6.70	7.12
Loss on ignition (excluding moisture)	82.35	84.98	83.95	85.20	87.30	80.11
Ash	12.65	10.50	11.45	8.30	6.00	12.37
Oil	0.45	0.80	1.40	1.70	1.60	2.70
Crude fibre	5.70	6.20	23.10	6.80	12.40	21.60
Total nitrogen	5.82	5.15	5.06	4.71	3.77	3.10
Total P_2O_5	1.50	1.38	1.45	1.15	1.24	1.13
Total K_2O	1.45	1.31	1.26	1.25	1.21	1.10
C/N ratio	8.21	9.43	9.75	10.49	13.09	15.00

The ammonification of native organic matter present in both the soils increased gradually up to a period of 30 days and therafter, it tended to decrease at succeeding intervals (Table 3, Fig. 1). There was no appreciable difference in the quantity of ammoniacal nitrogen produced from native organic matter in the two soils.

When the soils were treated with different oil cakes it was observed that the ammoniacal nitrogen gradually increased up to a period of 30 days and thereafter showed a decreasing trend in all cakes except castor in both the soils. The maximum quantity produced varied from 17.99 mg to 28.66 mg and from 20.66 mg to 37.32 mg per 100 g of medium black calcareous and lateritic soil respectively. In case of castor, maximum ammonification was observed at the days (23.23 g and 32.66 g per 100 g in medium black calcareous and lateritic soil respectively) and the rate gradually decreased thereafter in both the soils. While considering the percentage of ammoniacal nitrogen produced from the total nitrogen added, it was observed that

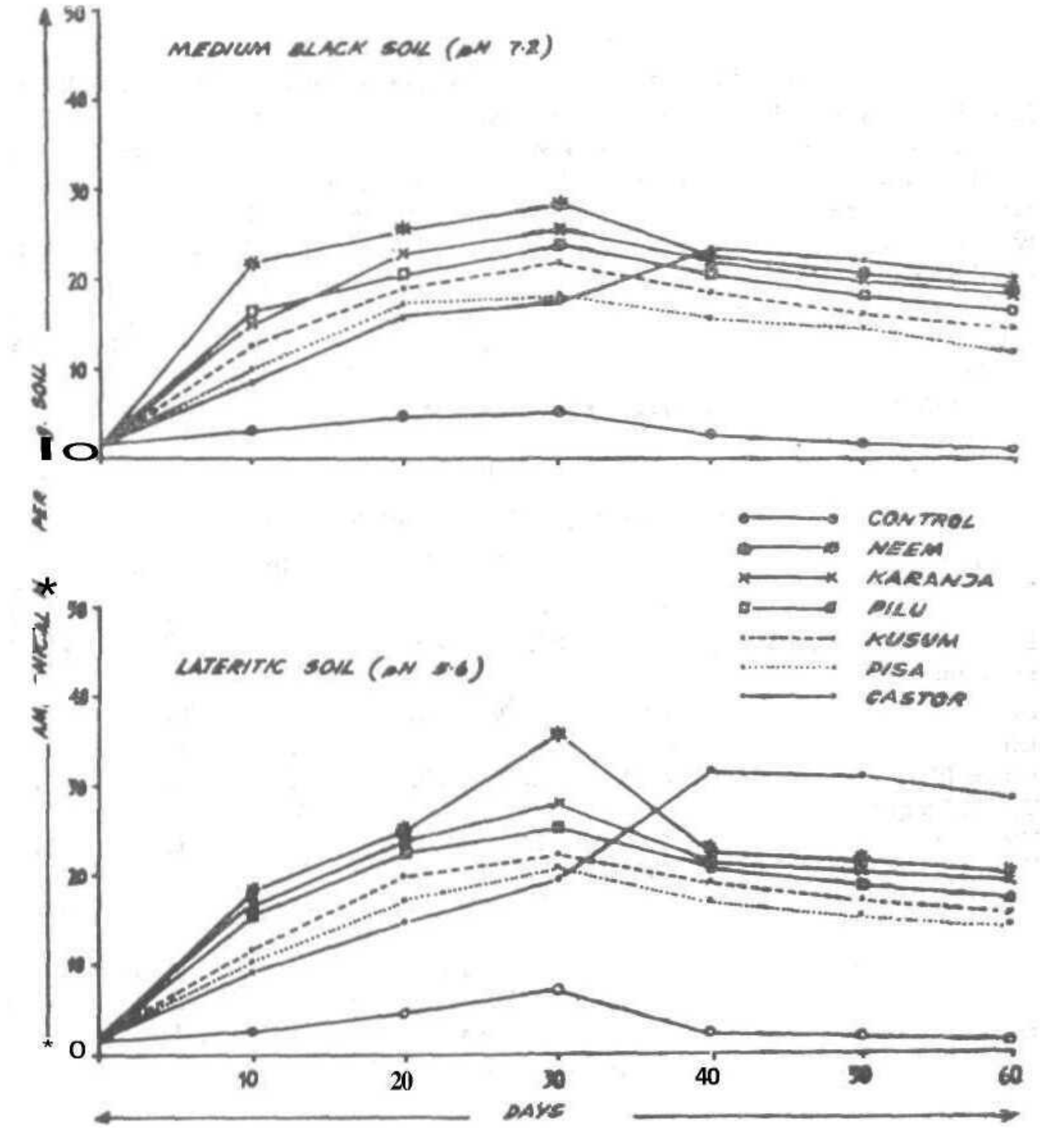

Fig. 1 Release of ammoniacal nitrogen in soils treated with non-edible oil cakes (ammonification)

the quantities varying from 12.6 to 23.3 per cent of the total nitrogen was ammonified during one month in medium black calcareous soil and about 13.4 to 31.3 percent in lateritic soil.

If the quantities of ammoniacal nitrogen produced by the various cakes in the two soils were compared, more quantities were found to have produced from all the cakes in lateritic soil, indicating better ammonification in lateritic soil than in

Table 3
Content of ammoniacal nitrogen in soils treated with non-edible oil cakes, mg/100g soil

	Period, days						
	0	10	20	30	40	50	60
				Medium blackcalcareoussoil			
Control	1.12	2.66	4.64	5.39	2.66	1.67	1.25
Soil + Neem cake	1.63 (0.51)	21.34 (18.68)	25.35 (20.71)	28.66 (23.27)	22.66 (20.00)	20.66 (18.99)	19.33 (18.07)
Soil + Karanja cake	1.64 (0.52)	15.33 (12.67)	23.33 (18.69)	25.99 (20.60)	22.00 (19.34)	19.33 (17.66)	18.66 (17.41)
Soil + Pilu cake	1.61 (0.49)	15.99 (13.33)	21.33 (16.69)	23.00 (17.61)	20.67 (18.01)	17.99 (16.32)	16.66 (15.41)
Soil + Kusum cake	1.55 (0.43)	12.00 (9.34)	19.35 (14.71)	22.00 (16.61)	18.66 (16.00)	15.99 (14.32)	15.32 (14.07)
Soil + Pisa cake	1.45 (0.33)	9.33 (6.67)	17.33 (12.69)	19.33 (13.94)	15.33 (12.67)	14.00 (12.33)	12.67 (11.42)
Soil + Castor cake	1.41 (0.29)	8.66 (6.00)	15.99 (11.35)	17.99 (12.60)	23,23 (20.57)	22.00 (19.33)	20.00 (18.75)
				Lateritic soil			
Control	1.24	2.51	4.65	5.95	2.76	1.95	1.33
Soil + Neem cake	1.85 (0.61)	18.33 (15.82)	25.74 (21.06)	37.32 (31.27)	22.67 (19.91)	21.33 (19.38)	19.34 (18.01)
Soil + Karanj cake	1.70 (0.46)	16.67 (14.16)	21.11 (19.46)	28.32 (22.37)	21.95 (19.19)	20.25 (18.30)	19.76 (18.43)
Soil + Pilu cake	1.65 (0.41)	16.46 (13.94)	22.66 (18.01;	25.35 (19.40)	21.01 (18.25)	18.55 (16.60)	17.73 (16.40)
Soil + Kusum cake	1.50 (0.26)	12.58 (10.07)	20.61 (15.96)	22.85 (16.90)	19.91 (17.15)	17.71 (15.76)	16.52 (15.19)
Soil + Pisa cake	1.47 (0.23)	10.35 (7.84)	17.57 (12.92)	20.66 (14.71)	17.21 (14.45)	15.54 (13.59)	14.36 (13.03)
Soil + Castor cake	1.36 (0.12)	9.33 (6.82)	15.62 (10.97)	19.34 (13.39)	32.66 (29.90)	31.00) (29.05)	29.00 (27.67)

Values in parentheses indicate the net ammonification expressed as percentage of the added nitrogen ammonified.

medium black calcareous soil. The laterite soil being acidic in reaction, might have favoured the retention of ammonia released from the decomposed cakes and hence more quantities in this soil. Basu and Rosario (1944), Narale(1966) and Abrol (1967) also reported that lateritic soil was a better ammonifier than medium black calcaroous soil.

It was further observed that the rate of production of ammonia was in the decreasing order of neem cake, karanja cake, castor cake, pilu cake, kusum cake and pisa cake. Castor cake though ammonified rather slowly initially, improved considerably after 30 days and topped the list thereafter. More or less similar trend of behaviour of these cakes towards ammonification was also observed in lateritic soil. Kulkarni (1959) pointed out that castor cake contained three toxic substances which are responsible for the delayed mineralisation of castor cake.

The rate of nitrification (Table 4, Fig. 2) of native organic matter was different in both the soils. At all the occasions of sampling, medium black calcareous soil produced more nitrate nitrogen than lateritic soil.

When different cakes were added to the soil, and allowed to decompose, the nitrate nitrogen produced gradually increased throughout the period of the experiment in both the soils. The amount of nitrogen, however, varied considerably. However the amount of nitrate nitrogen, produced varied considerably with the type of soil. The percentage of added nitrogen which was nitrified, gradually increased throughout the period. On the 60th day quantities varying from 7.67 to 19.68 per cent were recovered as nitrate nitrogen in the medium black calcareous soil as against 2 51 to 4.18 per cent in the lateritic soil. It indicated therefore that medium black calcareous soil was a better nitrifier than lateritic soil. Lower nitrification in lateritic soil may be attributed to higher acidic reaction and lack of adequate bases especially calcium in the soil which might have restricted the activities of nitrifying organisms in the soil. Similar observations were also reported by Agashe (1957), Kulkarnj (1958) and Abrol (1966).

The efficiency of the cakes in nitrification was in the decreasing order of neem cake, castor cake, karanja cake, pilu cake kusum cake and pisa cake. The castor cake nitrified slowly till 30th day but at succeeding intervals its nitrification rate steadily increased and came upto the second best in the order. The same rate of nitrification of castor cake till 30th day was exhibited in both cakes. Kulkarni (1958) also found that castor cake was inferior in the earlier periods to the other cakes tried.

According to Dhar *et al.* (1933) available ntrogen is the sum of ammoniacal and nitrate nitrogen. Lipman (1916) also considered the sum of the two forms for comparing the availability of nitrogen in an organic material. The total mineralised nitrogen (sum of the ammoniacal and nitrate nitrogen) produced by the different cakes in th soils is presented in Table 5 and graphically represented in Fig. 3.

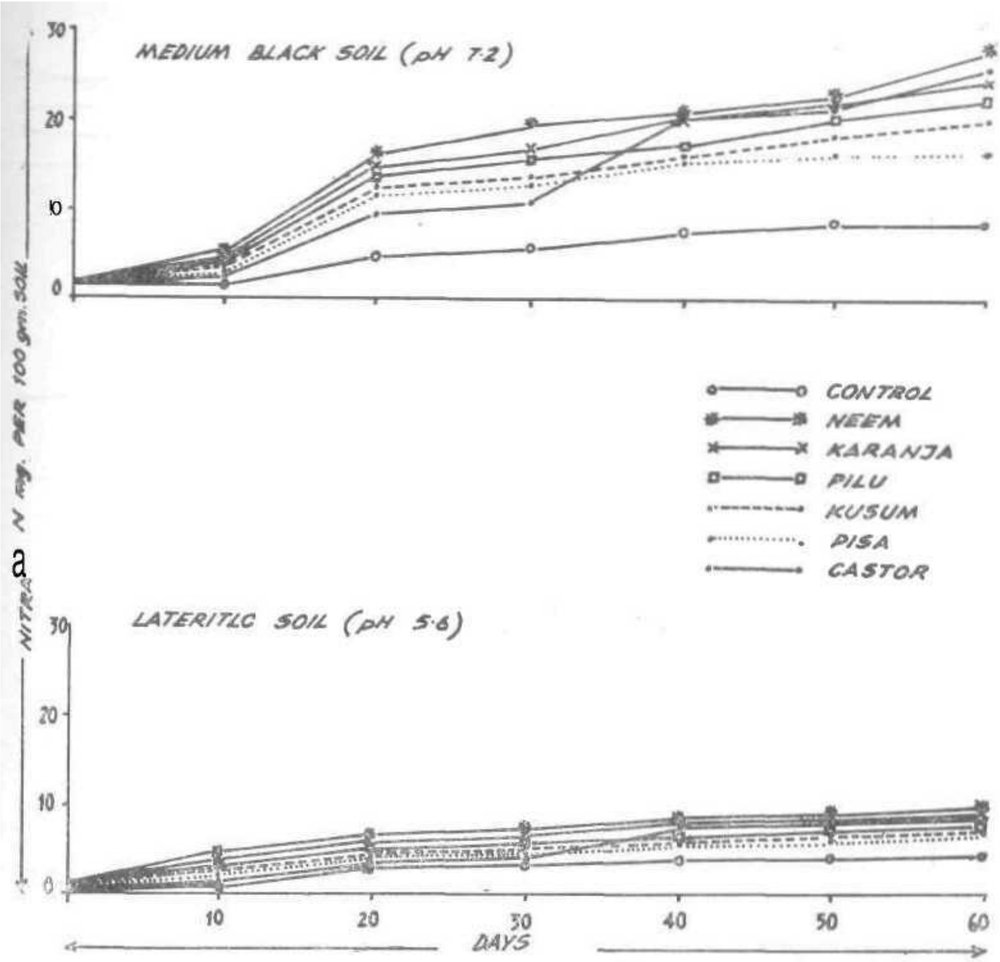

Fig. 2. Release of nitrate nitrogen in soils treated with non-edible oil cakes (nitrification)

The data in Table 5 revealed that mineralisation of nitrogen either from native or added organic material such as cakes was greatly influenced by the type of the soil and also by the nature of the material. Both native organic matter and added oil cakes considerably increased the total nitrogen in both the soils at all the intervals. The quantities of nitrogen produced in the medium black calcareous soil were much higher than those produced under lateritic soil, thus indicating the superiority of medium black calcareous soil in mineralisation of nitrogen from oil cakes.

The total quantities of nitrogen produced by various cakes in the two soils also varied with the cakes and production of more and more amount of nitrogen was observed to have been started from 30 days in both the soils and from all the cakes. Castor cake, however, continued to produce comparatively more and more nitrogen from 30 days onwards. In general, it was observed that 15 to 36 per cent of added

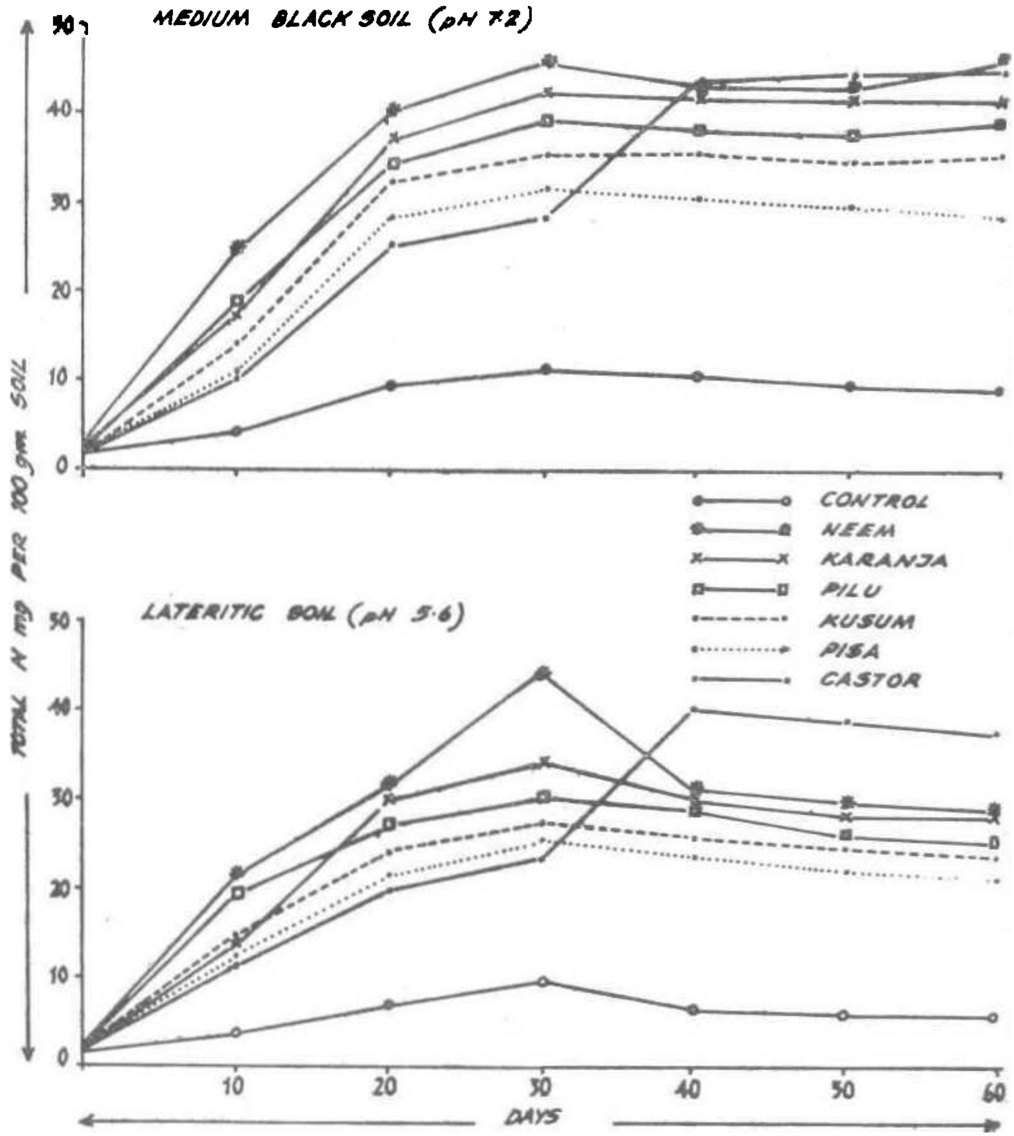

Fig. 3. Release of total nitrogen in soils treated with non-edible oil cakes

nitrogen through cakes are mineralised between 30 and 60 days in both the Neem cake was found to be superior to all the other cakes in the mineralisation of nitrogen, followed by castor cake, karanja cake, pilu cake, kusum cake and pisa cake in the descending order.

It may be noted from Table 2 that there was considerable variation in the composition of these cakes and this might have reflected on the variation in the decomposition of these cakes. Further scrutiny of Table 2 revealed that, eventhough all the

TabFe 4

Content of nitrate nitrogen in soils treated with non-edible oil cakes, mg/100 g soil

	Period, days						
	o	10	20	30	40	50	60
			Medium black calcareous soil				
Control	0.58	1.33	4.66	5.99	7.99	8.32	8.32
Soil + Neem cake	1.58	4.00	15.33	19.33	21.33	23.00	28.00
	(1.00)	(2.67)	(10.67)	(13.34)	(13.67)	(14.68)	(19.68)
Soii + Karanja cake	1.56	2.67	14.31	16.67	20.10	22.67	24.33
	(0.98)	(1.34)	(9.65)	(10.68)	(12.21)	(14.35)	(16.01)
Soii + Pilu cake	1.50	2.97	13.33	15.33	17.99	20.00	22.33
	(0.90)	(1.64)	(8.67)	(9.34)	(10.00)	(11.68)	(14.01)
Soil + Kusum cake	1.49	2.67	12.67	13.35	16.67	18.66	20.00
	(0.91)	(1.34)	(7.01)	(7.36)	(8.68)	(10.34)	(11.68)
Soii + Pisa cake	1.33	2.35	11.33	12.66	15.22	15.67	15.99
	(0.75)	(1.02)	(6.67)	(6.67)	(7.23)	(7.35)	(7.67)
Soii + Castor cake	1.33	2.33	9.33	10.66	20.67	22.09	26.50
	(0.75)	(1.00)	(4.67)	(4.67)	(12.68)	(13.67)	(18.58)
			Lateritic soil				
Control	0.20	1.33	3.00	3.10	4.00	4.32	4.48
Soil + Neem cake	0.83	2.67	5.33	6.99	7.99	8.33	8.66
	(0.63)	(1.34)	(2.33)	(3.89)	(3.99)	(4.01)	(4.18)
Soil + Karanja cake	0.69	2.33	5.00	5.99	7.4S	7.99	8.33
	(0.49)	(1.00)	(2.00)	(2.89)	(3.39)	(3 67)	(3.85)
Soii + Pilu cake	0.66	2.16	4.66	5.33	7.33	7.66	7.99
	(0.46)	(0.83)	(1.66)	(2.23)	(3.33)	(3.34)	(3,51)
Soil + Kausum cake	0.69	2.15	4.26	4.66	6.66	7.33	7.66
	(0,49)	(0.82)	(1.26)	(1.56)	(2.66)	(3.01)	(3.18)
Soii + Pisa cake	0.62	2.00	4.08	4.26	5.99	6.66	6.99
	(0,42)	(0.67)	(1.08)	(1.16)	(1.99)	(2.34)	(2.51)
Soil + Castor cake	0.60	1.99	3.83	4.16	7.66	7.99	8.35
	(0.40)	(0.66)	(0.83)	(1.06)	(3,66)	(3.67)	(3.87)

Values in parentheses indicate the net nitrification expressed as the percentage of added nitrogen nitrified

Table 5

Total mineralised nitrogen (ammoniacal-N + nitrate-N) in soils treated with non-edible oil cakes, mg/100 g soil

	Period, days						
	0	10	20	30	40	50	60
			Medium black calcareous soil				
Control	1.70	3.99	9.30	11.38	10.65	9.99	9.57
Soil + Neem cake	3.21	25.34	40.68	47.99	43.99	43.66	47.32
	(1.51)	(21.35)	(31.38)	(36.61)	(33.34)	(33.67)	(37.75)
Soil + Karanja cake	3.10	18.00	37.64	42.66	42.00	42.00	42.29
	(1.40)	(14.01)	(28.34)	(31.28)	(31.35)	(33.01)	(33.42)
Soil + Pilu cake	3.11	18.96	34.66	39.33	38.33	37.99	38.99
	(1.41)	(14.97)	(25.36)	(26.95)	(27.68)	(28.00)	(29.42)
Soil + Kusum cake	3.04	14.67	32.02	35.35	35.33	34.65	35.32
	(1.34)	(10.68)	(22.72)	(23.97)	(24,68)	(24.66)	(25.75)
Soil + Pisa cake	2.78	11.68	28.66	31,99	30.55	29.66	28.65
	(1.08)	(7.69)	(19.36)	(20.61)	(19.90)	(19.67)	(19.07)
Soil + Castor cake	2.74	10.99	25.32	28.33	43.90	44.09	46.50
	(1.04)	(7.00)	(16.02)	(16.45)	(33.25)	(34.00)	(36.93)
			Lateritic soil				
Control	1.44	3.84	7.65	9.05	6.76	6.27	5.81
Soil + Neem cake	2.68	21.00	31.07	44.31	30.66	29.66	28.00
	(1.24)	(17.16)	(23.42)	(35.26)	(23.90)	(23.39)	(22.19)
Soil + Karanja cake	2.39	19.00	29.11	34.31	29.44	28.24	28.09
	(0.95)	(15.16)	(21.46)	(25.26)	(22.68)	(21.97)	(22.28)
Soil + Piiu cake	2.31	18.61	27.32	30.68	28.34	26.21	25.72
	(0.87)	(14.77)	(19.67)	(21.63)	(21.58)	(19.94)	(19.91)
Soil + Kusum cake	2.19	14.73	24.87	27.51	26.57	25.04	24.18
	(0.75)	(10.89)	(17.22)	(18.46)	(19.81)	(18.77)	(18.37)
Soil + Pisa cake	2.09	12.35	21.65	24.92	23.20	22.20	21.35
	(0.65)	(8.51)	(14.00)	(15.87)	(16.44)	(15.93)	(15.54)
Soil + Castor cake	1.96	11.32	19.45	23.50	40.32	38.99	37.33
	(0.52)	(7.48)	(11.80)	(21.45)	(33.56)	(32.72)	(33.52)

Values in parentheses indicate the net amount of nitrogen released expressed as percentage of the added nitrogen mineralised.

cakes were deoiled, some amount of was still present in the cakes. Pisa cake contained the maximum of 2.70 per cent oil, while in neem cake it was only 0.45 per cent. The varying amount of oil in the cakes might have interfered in the process of decomposition to a certain extent. The rate of mineralisation of nitrogen from cakes showed decreasing trend with increasing oil percentage and hence mineralisation was very low in pisa cake. Karanjia (1953) an Desai and Rao (1957) also reported that presence of oil interfered in the process of mineralisation and completely deoiled cakes were superior to those containing oil.

Another constituent responsible for varying amounts of mineralised nitrogen might be the crude fibre content of the cakes. As the process of decomposition and mineralisation are microbial processes more amount of crude fibre, which is resistant to microbial attack, might have influenced in low activity of micro organisms and hence lower mineralisation in the cakes containing more of crude fibre. Neem cake which contained only 5.7 per cent crude fibre showed maximum mineralisation as compared to pisa cake containing 21.60 per cent crude fibre. Castor cake containing high amount of crude fibre, though showed reduced rate in the beginning, however was nitrified at later stages.

C/N ratio of the material might be considered as an important factor in the process of mineralisation. and Martin (1934) and many others reported that organic materials having narrow C/N ratio decompose early in the soil. The C/N *ratio* of various cakes (Table 2) showed th the ratio was highest (15.0) in pisa cake, followed by castor, karanja and was the lowest in cake (8.21). The rate of mineralisation observed was also similar, but in increasing order, maximum being in neem cake with lowest C/N ratio. Castor cake was however found to be an exception in which, the rate of mineralisation was increased after 40 days and was as _ as neem cake at 60 days.

Summary

An investigation on the mineralisation of nitrogen from 6 non-edible oil cakes, viz., neem, karanja, pilu, kusum, pisa and castor in two typical soils, viz., medium black calcareous and lateritic soils revealed that among the various cakes used, neem cake was the highest in th release of ammoniacal nitrogen followed by karanja, castor, pilu, kusum and pisa respectively in the descending order in both the soils. Lateritic soil was found to be a better ammonifier than medium black calcareous soils. The rate of nitrification was highest in neem cake followed by castor, karanja, pilu, kusum and pisa cake respectively in the descending order, in both the soils. Medium black calcareous soil was found to be a better nitrifier than lateritic soil. The total mineralised nitrogen from all the cakes was higher in medium black calcareous soil than in the lateritic soils. In both the soils, neem cake was the highest in this respect followed by castor, karanja, pilu, kusum and pisa cake in the descending order.

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