

A STUDY OF THE FLUCTUATIONS IN ORGANIC NITROGEN CONTENT OF BLACK COTTON SOIL UNDER VARYING CONDITIONS OF CROPPING.

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

INTRODUCTION.

In a series of laboratory experiments on wheat soils from the north of the C.P., conducted some years ago, it was observed (Bal, 1927) that no appreciable fixation of nitrogen occurred in these soils when incubated for varying periods of 2 weeks to 6 months, with adequate moisture content, but without any addition of organic matter. Even if there was a very small amount of nitrogen fixed (0.001 to 0.002%) it would mean an addition of 20 to 40 lbs. of nitrogen per acre per year which would be more than enough for an average annual wheat crop from such soils. It was considered desirable to study the organic nitrogen content of black cotton soil under field conditions during different seasons and the effect of different crops on soil organic nitrogen. This paper records the results obtained in this connection.

Determination of organic nitrogen content of black cotton soil during the period April to December.

In the first instance periodical determinations of organic nitrogen in unmanured black cotton soil, uncropped and cropped, were carried out for a period of nearly 7½ months from 16th April to 29th November. Uniform plots were selected on the Agricultural College Farm, Nagpur, and periodical soil samples were taken from these plots for purposes of analysis. Organic nitrogen in the various samples was determined by the modified Kjeldahl method, previously published by the writer (Bal, 1925), and the results obtained are given in Table I.

The results recorded in Table I show that the soil organic nitrogen fluctuates very considerably from time to time and that, both loss of nitrogen and recuperation of nitrogen appear to take place in the soil, under ordinary field conditions. These results are in accordance with the earlier observations recorded by Wilsdon and Barkatali (1922), and Lander and Barkatali (1925) in the case of Punjab soils and the recent observations of Sahasrabudhe and Abhyankar (1936) in the case of soils from the Bombay Presidency. It will be observed that out of the total of 34 nitrogen estimations carried out,

TABLE I.

Variations of organic nitrogen in black cotton soil.

Time of sampling			Percentages of organic nitrogen in dry soil			
Month		Date	Unmanured and uncropped		Unmanured and cropped with gram	
			Actual	Average	Actual	Average
April	..	16	0.057	0.055	0.054	0.057
"	..	30	0.053		0.060	
May	..	13	0.049	0.051	0.054	0.056
"	..	21	0.054		0.056	
"	..	24	0.051		0.057	
June	..	1	0.053	0.057	0.054	0.053
"	..	4	0.067		0.055	
"	..	9	0.052		0.052	
"	..	16	0.064		0.055	
"	..	30	0.048		0.050	
July	..	9	0.061	0.056	0.055	0.053
"	..	14	0.057		0.056	
"	..	19	0.055		0.052	
"	..	24	0.056		0.052	
"	..	29	0.053		0.051	
August	..	9	0.057	0.058	0.050	0.050
"	..	14	0.053		0.049	
"	..	19	0.060		0.048	
"	..	24	0.061		0.053	
September	..	2	0.054	0.057	0.049	0.052
"	..	8	0.059		0.052	
"	..	16	0.055		0.052	
"	..	22	0.058		0.051	
"	..	28	0.060		0.058	
October	..	5	0.065	0.060	0.053	0.051
"	..	13	0.062		0.048	
"	..	21	0.056		0.052	
"	..	28	0.058		0.050	
November	..	1	0.053	0.055	0.064	0.059
"	..	10	0.056		0.066	
"	..	13	0.060		0.052	
"	..	15	0.054		0.061	
"	..	24	0.059		0.066	
"	..	29	0.050		0.048	

13 show a loss of nitrogen of more than 4% in the case of the uncropped plot, and 8 only in the case of the plot cropped with legume. Nitrogen content of the cropped plot rose up appreciably in the month of November. There was no definite indication of any particular periodical decrease or increase in

the nitrogen content of the soil due to season, during the period covered by the investigation.

Nitrogen fixation capacity of black cotton soil at different periods.

Samples of soil were taken from two experimental plots, one being kept fallow and the other being cropped with *Rabi* crops. Samples were taken at an interval of 10 days during the period—15th of May to 24th of November. Amount of nitrogen fixed in Ashby's mannite solution by the soil, representing the various samples, was determined in duplicate and the results obtained are recorded in Table 2.

TABLE 2.

Nitrogen fixed by one gram of soil per gram of mannite.

Month	Average amount of nitrogen fixed in milligrams after 14 days' incubation at room temperature (average of duplicate flasks)	
	Soil from the fallow plot	Soil from the cropped plot
May	10.50	9.80
June	9.75	8.72
July	9.94	9.19
August	8.68	8.44
September	9.19	8.40
October	8.75	8.26
November	9.03	8.26

The results given in Table 2 indicate a higher nitrogen fixation capacity of the fallow soil than that of the cropped soil. Periodicity in nitrogen fixation capacity is not well marked, as was observed by Walton (1915). Nitrogen fixation is, however, somewhat higher in the months of May, June and July than that in the months of August to November.

Effect of growing annually wheat and legumes, alone or in a mixture, on the nitrogen content of the black cotton soil.

With a view to determining the fluctuations in organic nitrogen content of the soil under controlled conditions, the following pot culture experiments were carried out for a period of nine years :—

A quantity of black cotton soil from the Agricultural College Farm, Nagpur, was obtained and was mixed very thoroughly and several samples of the mixed soil were taken for the determination of initial organic nitrogen present therein. The mixed soil, without any addition of organic manure

TABLE

Organic nitrogen in soil

No. of pots	Crops grown	AVERAGE AMOUNT OF ORGANIC								
		1922	1923		1924		1925		1926	
		Initial at start	Removed by crop	Present in the soil	Removed by crop	Present in the soil	Removed by crop	Present in the soil	Removed by crop	Present in the soil
1 } 16 }	Uncropped ..	7.415	<i>nil</i>	7.576	<i>nil</i>	8.434	<i>nil</i>	9.065	<i>nil</i>	9.357
2 } 15 }	Wheat annually ..	7.415	0.042	7.592	0.023	7.926	0.023	9.190	0.024	8.721
3 } 14 }	Gram annually ..	7.415	0.138	7.909	0.634	8.537	0.119	9.467	0.041	9.201
4 } 13 }	Mixed wheat and gram annually.	7.415	0.106	7.852	0.133	8.076	0.095	9.533	0.088	8.915
5 } 12 }	Lakh annually ..	7.415	0.102	7.806	0.118	8.402	0.184	9.065	0.038	8.881
6 } 11 }	Mixed wheat and lakh annually.	7.415	0.068	7.996	0.092	8.171	0.187	8.673	0.081	9.775
7 } 10 }	Masur annually ..	7.415	0.022	7.782	0.141	8.100	0.272	8.900	0.157	8.994
8 } 9 }	Mixed wheat and masur annually.	7.415	0.035	7.569	0.088	8.123	0.152	8.737	0.092	8.978
	S.E.			0.216		0.245		0.287		0.366
	S.E.%			2.77		2.17		3.00		4.02

III.

from various pots.

NITROGEN PER POT IN GRAMS

1927		1928		1929		1930		1931		Average of 9 years 1923-1931
Removed by crop	Present in the soil	Removed by crop	Present in the soil	Removed by crop	Present in the soil	Removed by crop	Present in the soil	Removed by crop	Present in the soil	
<i>nil</i>	9-538	<i>nil</i>	8-878	<i>nil</i>	10-000	<i>nil</i>	11-202	<i>nil</i>	9-758	9-313
0-045	9-490	0-044	8-680	0-028	9-610	0-013	11-114	0-004	9-840	9-128
0-048	10-220	0-157	9-348	0-075	9-850	0-073	11-175	0-059	11-030	9-622
0-082	9-551	0-121	9-004	0-080	10-172	0-087	10-811	0-055	10-830	9-421
0-072	9-744	0-131	9-316	0-092	9-704	0-140	11-256	0-085	11-590	9-528
0-113	9-909	0-112	9-530	0-105	10-087	0-126	11-350	0-109	11-060	9-613
0-145	9-475	0-023	9-617	0-109	9-800	0-113	10-582	0-051	11-010	9-362
0-102	9-640	0-053	8-362	0-094	9-363	0-061	10-348	0-059	10-490	9-066
	0-366 3-77		0-381 4-19		0-399 4-06		0-950 8-65		0-400 3-73	0-150 1-60

or fertilisers, was then filled in 16 pots of equal size. Thirty-five pounds of soil were added to each pot and crops were grown annually as required. A representative sample of the various types of seed used for sowing was analysed every year. The amount of nitrogen added to the soil by the seeds employed for sowing, the amount of nitrogen removed by the crop, and the amount of nitrogen left in the soil before subsequent crop was sown, were determined every year. In the case of the cropped pots either 10 plants of wheat only or 5 plants of wheat and 5 plants of the appropriate legume were grown as required.

The types of crops grown in the various pots and the results of annual determinations of nitrogen in the soil are given in Table 3. The results show the following :—

(1) The organic nitrogen content fluctuates from year to year. A remarkable increase in the nitrogen content of the soil from all the pots has occurred in the year 1930.

(2) The nitrogen content of the soil, at the close of the period of 9 years, is appreciably more than that initially present.

(3) Growing wheat annually for a period of 9 years does not appear to have caused any deterioration in soil organic nitrogen. At Rothamsted, in the case of the unmanured Broadbalk wheat plot, it was found that although there was a very little decrease in the actual nitrogen content of the soil after a period of 48 years, the nitrogen balance sheet drawn after taking into consideration the wheat crop obtained, showed a gain of one pound of nitrogen per acre per year (Russell, 1926).

(4) Growing a mixture of wheat and legumes annually does not show any significant increase in soil organic nitrogen over that found in the soil growing wheat alone.

The writer expresses his thanks to Dr. R. J. Kalamkar for having calculated the figures of standard error included in Table 3 and to Mr. R. N. Misra, Assistant to the Agricultural Chemist, for the help rendered by him in connection with some of the analyses of soils and crops.

SUMMARY.

(1) Results of (a) periodical determinations of organic nitrogen and nitrogen fixation capacity, in black cotton soil under field conditions, and (b) pot culture experiments conducted to study the effect of fallowing and cropping with various crops, on soil organic nitrogen, have been given.

(2) It has been observed that organic nitrogen in black cotton soil, under varying conditions of cropping, fluctuates very considerably from time to time.

(3) Under field conditions both loss of nitrogen and recuperation of nitrogen take place, but the latter process appears to be of a more frequent nature than the former.

(4) No definite indication of any periodical decrease or increase in the nitrogen content of the soil due to season was noticeable, but the nitrogen fixation power of the soil was found to be somewhat higher in the months of May, June and July, than that in the months of August to November.

(5) In the pot culture experiments conducted for a period of 9 years, it was observed that the nitrogen content of the soil from all the pots at the close of the experiment was appreciably more than that initially present, and in the year 1930 it had increased rather remarkably.

(6) Growing wheat annually for a period of 9 years has not caused any deterioration in soil organic nitrogen.

(7) Growing a mixture of wheat and legumes annually does not show any significant increase in soil organic nitrogen over that found in the soil growing wheat alone.

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