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BACTERIA IN SOME IOWA SOIL PROFILES

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Recent developments in soil science have called attention to the importance of studying and describing soils according to their profile characteristics. The various horizons or layers represented in each profile have certain definite and significant characteristics which may aid in the classification of the soils and may also have some effect on the fertility or crop producing power of the soil. The chemical and physical properties of the distinct horizons in typical soil profiles are being studied and some interesting data are being secured. The study will not be complete, however, until there is investigation of the biological properties of the profiles.

The data reported here were secured in connection with the study of the content of microörganisms in some typical soil profiles in Iowa.

Samplings were made of typical profiles of Marshall silt loam and Knox silt loam in cultivated areas in Crawford county on July 29, August 28, September 23, October 12 and November 23, 1927. These are two very important soils in the western part of the state. Samples were taken from the various horizons with the usual precautions and the numbers of bacteria, actinomycetes and molds were counted on agar plates. The ordinary dilution method was followed and Brown's egg albumen agar was used for the bacteria and actinomycetes and Waksman's synthetic acid mold medium was employed for the molds. The moisture content of the samples was determined in all cases and the results are calculated on an air-dry basis. The data are given in table I.

Careful descriptions were made of the horizons of each profile studied. They are given below.

Marshall Silt Loam. No. 30

IN.	IN.	
0	2	— dark brown smooth silt loam.
2	6	— dark brown smooth silt loam.
6	12	— dark brown smooth silt loam.
12	20	— brown to dark brown heavy silt loam, highly stained with organic infiltrations.

(Contribution from the Laboratory of Soil Chemistry and Bacteriology, Iowa State College.)

Table I — Microörganisms in Some Soil Profiles in Iowa

Soil Type	Date Sampled 1927	Depth Soil Horizon Inches	Per-cent H_2O	Bacteria Per Gram Air-Dry Soil	Actinomycetes Per Gram Air-Dry Soil	Molds Per Gram Air-Dry Soil
Marshall silt loam No. 30	July 29	0 – 2 A_1	16.0	4,280,000	840,000	950
		2 – 6 A_2	15.0	4,470,000	920,000	1,290
		6 – 12 A_3	16.0	3,690,000	590,000	1,660
		12 – 20 B_1	15.5	510,000	82,000	820
		20 – 25 B_2	14.0	410,000	46,000	93
		35 – 50 C_1	13.5	68,000	5,700	23
Knox silt loam No. 31	July 29	0 – 2 A_1	14.0	3,950,000	580,000	810
		2 – 6 A_2	16.0	4,160,000	720,000	1,070
		6 – 16 A_3	15.0	3,370,000	480,000	1,204
		16 – 30 B_1	14.0	300,000	69,000	162
		30 – 50 C_1	12.0	125,000	56,000	68
Marshall silt loam No. 32	Aug. 28	0 – 2 A_1	14.0	3,600,000	698,000	695
		2 – 6 A_2	11.5	1,920,000	511,000	1,350
		6 – 16 A_3	17.0	1,879,000	361,000	1,200
		16 – 26 B_1	16.5	179,000	64,900	119
		26 – 50 C_1	16.0	107,000	86,900	83
Knox silt loam No. 33	Aug. 28	0 – 2 A_1	11.0	2,470,000	426,000	1,120
		2 – 6 A_2	10.5	2,301,000	670,000	670
		6 – 15 A_3	13.5	2,080,000	506,000	570
		15 – 28 B_1	12.0	272,000	46,000	45
		28 – 50 C_1	10.5	156,000	24,000	24
Marshall silt loam No. 34	Sept. 23	0 – 2 A_1	12.0	4,772,000	795,000	1,931
		2 – 6 A_2	14.0	5,581,000	697,000	1,041
		6 – 18 A_3	15.0	4,589,000	352,000	135
		18 – 22 B_1	12.0	750,000	125,000	79
		22 – 34 C_1	11.0	348,000	56,000	44
		34 – 50 C_2	11.0	55,600	7,860	11
Knox silt loam No. 35	Sept. 23	0 – 2 A_1	8.0	3,040,000	326,000	1,300
		2 – 6 A_2	10.0	3,660,000	222,000	1,100
		6 – 14 A_3	12.0	1,818,000	227,000	90
		14 – 34 B_1	10.0	266,000	77,000	100
		34 – 50 C_1	7.0	96,000	43,000	43
Marshall silt loam No. 36	Oct. 12	0 – 2 A_1	14.0	5,110,000	581,000	1,650
		2 – 6 A_2	19.5	4,340,000	911,000	1,810
		6 – 16 A_3	18.5	4,171,000	492,000	1,630
		16 – 27 B_1	18.3	305,000	73,000	110
		27 – 37 C_1	17.5	108,000	48,000	96
		37 – 50 C_2	11.5	42,900	4,200	22
Knox silt loam No. 37	Oct. 12	0 – 2 A_1	16.0	3,570,000	830,000	2,850
		2 – 6 A_2	17.0	4,096,000	960,000	1,560
		6 – 14 A_3	17.5	2,780,000	350,000	104
		14 – 34 B_1	14.0	209,000	58,000	69
		34 – 50 C_1	11.0	89,000	33,000	26
Marshall silt loam No. 38	Nov. 23	0 – 2 A_1	15.0	3,520,000	588,000	1,240
		2 – 6 A_2	14.5	3,390,000	729,000	1,930
		6 – 14 A_3	14.5	2,540,000	608,000	67
		14 – 28 B_1	11.0	277,000	44,000	11
		28 – 50 C_1	10.5	136,000	10,000	21
Knox silt loam No. 39	Nov. 23	0 – 2 A_1	12.0	3,060,000	454,000	1,700
		2 – 6 A_2	15.0	3,640,000	705,000	2,470
		6 – 12 A_3	15.0	2,000,000	470,000	129
		12 – 30 B_1	14.0	150,000	58,000	46
		30 – 50 C_1	13.0	80,000	34,000	11

20 – 35 — light yellowish brown silty clay loam.
35 – 50 — same as 20 – 35 in. except slightly lighter in color and more friable.

KNOX SILT LOAM. No. 31

IN. IN.
0 – 2 — brown silt loam.
2 – 6 — brown silt loam.
6 – 16 — light yellowish brown smooth silt loam, calcareous.
16 – 30 — pale yellowish floury silt loam, highly calcareous.
30 – 45 — same as 16 – 30 in. except occasionally light grayish lines or thin streaks and splotches and somewhat more floury.

MARSHALL SILT LOAM. No. 32

Similar to No. 30 except dark grayish brown in color to 16 inches.

KNOX SILT LOAM. No. 33

Similar to No. 31 except grayish brown in color to 6 inches.

MARSHALL SILT LOAM. Nos. 34, 36, 38

Similar to No. 32.

KNOX SILT LOAM. Nos. 35, 37, 39

Similar to No. 33 except that the B horizon (14 in. – 34 in.) or (12 in. – 30 in.) is somewhat heavier in texture.

There are some variations in the depths of the various horizons in the soils and some minor differences in characteristics which are not listed here. The horizon differences are shown in the table.

Examining the data given in the table it is apparent that the numbers of bacteria vary somewhat in the same soil types at the different dates of sampling. What brings about this variation in numbers cannot be determined from these data. It seems probable, however, that the variations are due to seasonal changes rather than to differences in the typical soils sampled. Undoubtedly the differences in typical Marshall silt loam and Knox silt loam areas are of minor importance.

On July 29, there were 4,280,000 bacteria in the A_1 horizon; on August 28 there was a decrease; on September 23 an increase occurred; on October 12 a further increase was found which was followed by a decrease on November 23. In the A_2 horizon, a very large decrease occurred at the August sampling followed by a particularly large increase in September, the number going above that in the A_1. Decreases followed at the later dates. Similar results were secured at the lower depths until the C horizon was reached, where the numbers were greater at the samplings when the numbers in the surface horizons were the smallest. It is interesting to note also the very quick dropping off in bacterial number when going from the B_2 to the C horizon. This is shown especially in No. 30 and No. 34.

The numbers of actinomycetes vary in much the same way as

do the bacteria. There is a decrease from July to August followed by an increase in September. At this point the actinomycetes decreased while the bacteria continued to increase until November. After the September maximum, the number of actinomycetes decreased to October and November except in the A_2 horizon where an increase occurred in October, followed by a decrease in November. It is interesting to note the large numbers present in the A_3 horizon at the November sampling indicating a movement downward in the soil, or an increase brought about by the decrease in numbers of bacteria. At the lowest depths the actinomycetes varied from 4,200 per gram up to 10,000 per gram, if the count of 86,900 on August 28 is not included. That figure seems very high and may be an abnormal result.

The content of molds is low in this soil at the surface, at all samplings being greater in the A_2 horizon in July and August, October and November, and greater in the A_1 horizon only in September. The seasonal effects were not pronounced but in the A_1 horizon a decrease occurred to August followed by an increase to September and October and a decrease to November. At the A_2 horizon, the results were different, an increase occurring in August and a decrease in September followed by an increase in October and in November. There are variations also at the lower depths but in general they are not very significant. There is some evidence that the mold counts are the opposite of the bacterial. When bacteria decrease, the molds often increase and vice versa. However, this does not always hold true, depending apparently upon the particular seasonal or soil condition which causes the change in bacteria numbers.

Considering the data on the Knox silt loam, it is apparent first of all that the number of bacteria is much less at all dates of sampling than in the Marshall silt loam. This might be expected since the Knox is a poorer soil, lower in organic matter and nitrogen and lighter in color than the Marshall. The differences are particularly large in the A_1 horizons and in some cases in the A_2 horizon. On August 28, the A_2 and A_3 horizons of the Knox silt loam contained more bacteria than the same horizons of the Marshall silt loam. On November 23, there were more bacteria in the A_2 horizon of the Knox than in the A_2 horizon of the Marshall. At the lower depths there are not important or consistent differences in bacterial content of the two types.

There was a decrease in bacteria in the A_1 horizon of the Knox silt loam from July to August. Then an increase occurred in September and in October and a slight decrease in November. The

same variations occurred in the A_2 horizons and in the A_3 horizon except in one case. At the lowest depths the numbers decreased throughout the season but the differences in several cases were not significant.

The content of actinomycetes was less in the Knox silt loam than in the Marshall silt loam except at the October sampling at which time there were more actinomycetes in the A_1 and A_2 horizons of the Knox. The variations in numbers of these organisms followed very closely the changes in numbers of bacteria. At four out of the five samplings there was a much greater number of actinomycetes in the A_2 horizon than in the A_1. Only in September was the reverse the case. In some instances there was a very large decrease to the A_3 but not in all cases. The greatest decrease always occurred, however, between the A_3 and the B_1 horizons. Large decreases occurred from the B_1 to the C_1 horizons and the numbers were much smaller.

The numbers of molds were less in the Knox silt loam than in the Marshall, in the A_1 and A_2 horizons at the July and September samplings, but at the August, October and November samplings there were more molds in the Knox. In October the greatest mold count was secured in the surface soil of the Knox. In November the greatest count occurred in the A_2 horizon. In several other cases there were more molds in the A_2 horizon than in the A_1. The lower horizons were very low in mold content and no important differences were noted.

From these results as a whole it would seem that the content of microörganisms in the various horizons of typical soil profiles is certainly closely correlated with those characteristics which serve to distinguish the horizons. In typical samples the numbers vary through the season, the seasonal effects being shown not only at the surface, where the greatest differences occur, but also at the lowest depths. Minor variations occur in the microöganic content of different profiles of the same type but greater differences occur between types and especially in the lower horizons.

The numbers of various microörganisms may show something of the characteristics of the individual soil horizons and hence may indicate what changes are going on in the particular soil layers. Further studies of the activities of various groups of organisms in soil horizons will throw much more light on this problem.

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