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The soil survey of Monona County has involved the mapping and study of many soil types in this western Iowa county. Somewhat unusual in Iowa is the occurrence of alkali in a portion of the Missouri River bottomlands. These alkali soils are being classified in the Napa series—a soil series occurring in adjacent Nebraska and in South Dakota. They are associated with the Luton series, a Humic-Gley or Wiesenboden soil of fine textured alluvial material. Similar alkali soils may occasionally occur in other Iowa counties along the Missouri River. They are generally more common in counties to the north of Monona County than to the south.

The major soil groups of the Missouri River bottomlands of Monona County have been described by McClelland et al (1). The differences between the soils of the bottomlands are attributed to geological processes related to stream action, and the soil textures are related to the depositional patterns of the river flood waters that spread out over the valley floor. Soils in the Luton group are described as dark colored, poorly drained soils of clay texture. They occupy a very shallow trough on the eastern side of the bottomlands protected from floods by old natural levees.

The slope gradient of the area of Luton soils is about one foot per mile to the southeast. Thus there is inadequate surface drainage. The clay subsoils have a very slow permeability to water. This results in soils which have very poor natural internal aeration.

The alkali soils in Monona County, the Napa series, are found in the northern part of the area of Luton soils adjacent to the Woodbury County line. The general area in which the Napa and Luton soils are associated is shown in Figure 1. The Luton soils do have a wider occurrence in Monona County as indicated by McClelland et al (1) than the area in which they are associated with the Napa soils. The orientation of the alkali soils in the center of the shallow trough of the Luton soils is in a northwest-southeast direction.

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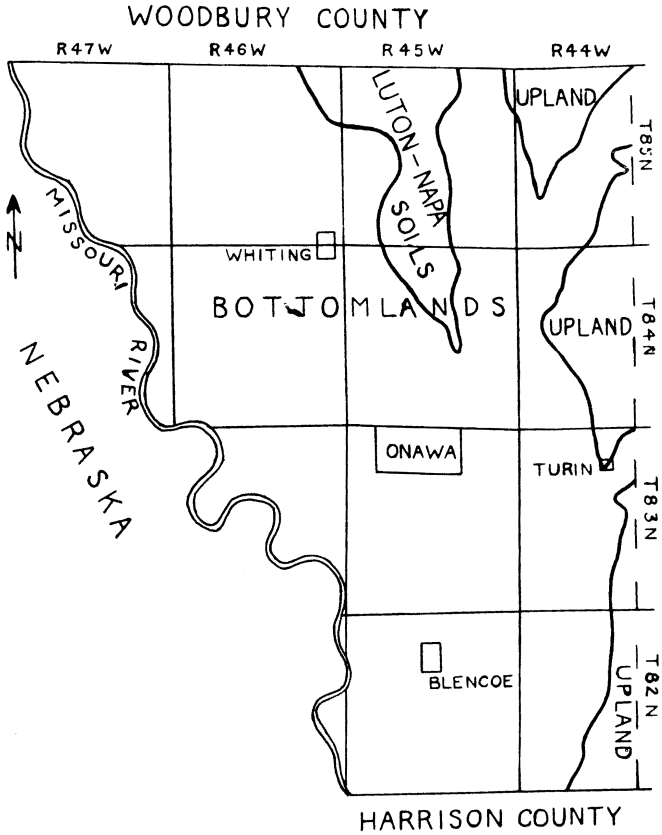

Figure 1. Location of the Luton-Napa soil association in the Missouri River bottomlands of western Monona County.

Soil samples were obtained in Monona County in October, 1949 to determine some of the characteristics of the alkali soils and to compare them with the associated soils. Two profiles were selected: Napa clay and Luton clay. These were obtained 34 yards apart in a corn field 150 yds. south and 50 yds. east of the northeast corner of NW¼ of SW¼ Section 3, R45W, T85N. In addition to the two profiles, surface samples were obtained from two alkali areas in the same vicinity which appeared to be of higher salinity than the area selected for the profile sample of Napa clay.

Soil Profile Descriptions

Napa clay, profile no. P-152.

0-¼″ Dark gray (10YR4/1)* friable silt loam with very weakly developed platiness and very slightly vesicular. This material appears to have accumulated on the surface during rains.

¼-5″ Very dark gray (10YR3/1) very plastic noncalcareous silty clay with moderately developed coarse blocky structure. Very hard when dry. This horizon contains small accumulations of dark gray (10YR4/1) to grayish brown (10YR5/2) silt loam material which appears to have been turned under from the surface by plowing in previous seasons.

5-9″ Very dark gray (10YR3/1) very plastic noncalcareous silty clay, weakly developed medium blocky structure.

9-14″ Very dark gray (10YR3/2) very plastic silty clay with light mottling, moderately developed medium blocky structure. Calcareous in numerous lime segregations.

14-20″ Dark gray (2.5Y4/1) very plastic silty clay with small olive brown (2.5Y4/3) mottlings, moderately developed medium blocky structure. Calcareous with lime disseminated through soil mass and in soft segregations.

20-28″ Olive gray (5Y4/2) but toward 2.5Y4/2 very plastic silty clay with light olive brown (2.5Y5/4) mottling and very small dark 10YR3/2 concretions. Weakly developed medium blocky structure. Calcareous with lime disseminated and in soft segregations.

Luton clay, profile no. P-151.

0-5″ Very dark gray (10YR3/1) plastic noncalcareous light silty clay with weakly developed very fine granular structure. Contains many worm holes.

5-12″ Black (10YR2/1) very plastic noncalcareous silty clay with moderately developed medium blocky structure. Fewer worm holes than in surface horizon.

12-16″ Very dark gray (10YR3/1) very plastic silty clay moderately developed medium blocky structure. Moderately calcareous with a few soft lime segregations.

16-20″ Very dark gray (2.5Y3/1) very plastic silty clay with light olive brown (2.5Y5/4) mottlings and light brownish gray (2.5Y6/2) soft lime segregations. Moderately strong medium coarse blocky structure. Moderately hard when dry. Calcareous with lime disseminated through soil mass in addition to the segregations.

20-28″ Dark grayish brown (2.5Y4/2) plastic silty clay with light olive brown (2.5Y5/4) mottling and light brownish gray (2.5Y6/2) soft lime segregations. Strongly developed coarse blocky structure. Entire soil mass is calcareous in addition to lime segregations.

A partical size analysis of a Luton profile obtained 13 miles south of the profiles described above has been made by Davidson[1]. This profile contained 46.8 percent clay (less than 2 microns) in

*Colors of moist soil using standard color names and Munsell color designations (4).

[1]Unpublished data, Department of Agronomy, Iowa State College.

Table 1

Laboratory data for Napa and Luton soils.

Sample Depth	Bulk Density	Moisture Content at Sampling	Saturation %	Conductivity of Saturation Extract	pH paste	pH 1:1	pH 1:5	Soluble Sodium	Exchange Capacity	Exchangeable Sodium		Nitrogen
Inches		%		Millimhos/cm. at 25°C.				ME/100gm	ME/100gm	ME/100gm	%	%
	Napa clay, P-152											
0-¼			43.1	1.5	6.8	7.1	7.6	.38	20.7	1.64	7.9	0.12
¼-5	1.21	25.4	49.6	1.5	7.0	7.3	7.7	.58	25.2	2.83	11.2	0.14
5-9	1.30	24.2	78.3	2.6	8.3	8.4	9.2	1.79	36.2	7.52	20.8	0.09
9-14	1.32	25.7	86.6	4.2	8.3	8.4	9.1	3.29	35.7	9.12	25.5	0.07
14-20	1.39	25.1	78.4	5.7	8.3	8.5	9.2	4.06	30.8	8.29	26.9	0.06
20-28	1.40	25.0	93.9	4.5	8.3	8.4	9.2	3.91	29.3	8.50	29.0	0.03
	Luton clay, P-151											
0-5	1.23	26.5	52.2	0.7	6.2	6.4	6.8	.09				0.21
5-12	1.36	27.2	63.2	0.6	6.8	7.3	7.8	.22				0.10
12-16	1.33	22.7	72.1	0.7	7.5	7.9	8.5	.33				0.07
16-20			72.8	1.0	8.1	8.4	9.1	.50				0.05
20-28	1.38	20.8	89.7	1.1	8.3	8.5	9.2	.84				0.04
	Napa clay, surface soil											
0-6			54.3	14.								
	Napa clay, surface soil											
0-½			46.4	32.								
½-6			74.2	2.9								

the surface soil, and the clay content increased to a maximum of 56.7 percent in the 25 to 30 inch horizon.

Determinations commonly made for the characterization of saline and alkali soils are discussed by Richards (3). These include measurement of the salt content, pH, soluble and exchangeable sodium, and the exchangeable sodium percentage. Methods for these determinations and discussions of their significance are given in the U.S. Regional Salinity Laboratory Manual (2). The results of the determinations made on the soil samples from Monona County are given in Table 1.

The degree of salinity of the soil samples were measured by determining the conductivity of the soil solution obtained from the saturated soil paste. This solution is called the saturation extract and the moisture content of this saturated soil paste, the saturation percentage (2). The conductivity is expressed in millimhos per centimeter at 25° C. Such measurements are more precise than measuring the resistance of the saturated soil paste with a Wheatstone bridge (4). Soil samples having conductivities of the saturation extract greater than 4 millimhos per centimeter are considered to be saline (2). The saturation percentage is the lowest convenient moisture content for obtaining a soil solution. Richards (3) indicates that it is approximately double the field capacity and four times the wilting percentage. The conductivity measurements are thus related to the soil solution at field capacity, the high moisture retention of clay soils and dilution of the salt automatically corrected.

The conductivities of the saturation extracts indicate that the Napa clay has a greater salinity than the Luton clay. The Napa profile is slightly saline below a depth of nine inches while the Luton profile is not considered saline within the depth sampled. The surface soil samples from nearby areas of Napa clay are strongly saline. Thus there is considerable variation in the salinity of Napa soils. Accumulation of salt at the soil surface is indicated for the area sampled at two shallow depths.

The saturation percentages of these soils are high as would be expected for soils of clay texture. The saturation percentages of the Napa profile are consistently higher than for the Luton profile. It is not known how much the clay content varies in these profiles since mechanical analyses were not made.

Richards (3) discusses the relationship of soil pH and sodium content. He states that no usable relation has been found. The soil pH is influenced by many factors, of which the sodium content is only one. However, soils with a high sodium content often do have a high pH. The pH of a soil-water suspension usually increases as the amount of water increases. This increase has been used as an indication of the exchangeable sodium. Richards states, however, that there does not appear to be a useful relationship between the exchangeable sodium percentage and the increase of pH upon dilution.

The pH of the surface horizon of the Napa profile is near neutral. The pH values of the horizons sampled below a depth of 5 inches are uniform. The soil pastes have a pH of 8.3, and for the 1:5 soil-water dilutions the pH increases to 9.2. The Luton profile surface soil is slightly acid. The pH increases with depth and reaches the same value as in the Napa profile in the lowest horizon sampled. A correlation of the pH with the salt content or exchangeable sodium is not apparent for these two profiles.

The sodium content of the saturation extracts was determined. This is considered to be soluble sodium. It is reported on the basis of milliequivalents of soluble sodium per 100 grams of soil. The soluble sodium in the Napa profile is from 5 to 10 times greater than in the corresponding depths of the Luton profile.

The exchange capacity and exchangeable sodium content were determined only for the Napa profile. The conductivity measurements and soluble sodium content suggested that the Luton profile would not have significant amounts of exchangeable sodium.

A lower limit of 15 percent exchangeable sodium has been set by the Salinity Laboratory for distinguishing alkali from non-alkali soils (2). Soils that contain more than 15 percent exchangeable sodium are usually unproductive because of poor physical conditions, low permeability, and poor aeration. With increasing exchangeable-sodium soils tend to become more dispersed, more impermeable, and difficult to till. This is particularly true when excess salts are not present to keep the soil flocculated.

Significant amounts of exchangeable sodium were found in the Napa profile as measured by the exchangeable sodium percentage. The exchangeable-sodium is sufficiently high to affect plant growth. The soil horizons sampled below a depth of 5 inches are alkali soils according to definitions of the Salinity Laboratory (2).

There does not appear to be any significant difference in the bulk density of the two profiles. The bulk density for both profiles increases from about 1.2 at the surface to about 1.4 in the 20 to 28 inch horizon. The moisture content at the time of sampling was determined from the bulk density samples. The moisture content in the Luton profile was lower than in the Napa. Apparently the soil moisture was depleted to a greater extent by the corn on the Luton soil than on the Napa soil which had very little vegetative growth.

Nitrogen determinations show a higher nitrogen content in the surface horizon of the Luton profile than in the Napa profile. Below a depth of 5 inches the nitrogen percentages of the two profiles are very similar. The nitrogen content of the Luton profile is somewhat less than that of the Luton profile reported by McClelland et al (1).

The Luton series is classified as a member of the Humic-Gley (Wiesenboden) great soil group (5) developed from fine-textured alluvial materials. This great soil group includes the intrazonal poorly to very poorly drained hydromorphic soils with dark-colored organi-mineral horizons of moderate thickness underlain by mineral gley horizons. The Napa series, although formed from the same alluvial material as the Luton series, varies in the content of soluble salts and exchangeable sodium. It appears from these samples that the Napa series may be an intergrade to the Solonchak—light-colored, flocculated, salty soils (4). The two areas for which surface soils only were obtained do have excess salts at the surface and are more flocculated. The Napa clay profile sampled is slightly saline, and with the high content of exchangeable sodium is more dispersed. There is a slight suggestion of horizon differentiation in the thin silt loam layer that was found at the soil surface. This silt loam surface horizon, however, is destroyed during cultivation.

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