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Relationship of Topography to the Distribution of Soils and to Loess Thickness on the Galva-Primghar Experimental Farm[1]

By R. C. Prill, W. D. Shrader, and R. P. Nicholson[2]

The preparation of a highly detailed soil map and a contour map of the Galva-Primghar Experimental Farm has provided an opportunity to study the relationship of topography to the distribution of soils and to the loess thickness pattern on the farm. A report on these relationships is given in this paper.

Area Studied

The Galva-Primghar Experimental Farm, an 80-acre tract of land, is located in southeastern O'Brien County in the N½ of the NW¼ of Section 8, Twp. 94 N., R. 39 W. This tract is covered by a thin mantle of Early Wisconsin loess that is underlain by Tazewell till (Ruhe, 1950). It is in the Galva-Primghar-Sac soil association area (Simonson, et al., 1952). The farm drains into two separate small watersheds with the west part draining to the west and the east part to the southeast.

Soils Mapped

In the preparation of the soils map, 50-inch or deeper borings were taken at intervals of 100 feet. When additional information was needed to establish the soil boundaries, borings were taken at closer intervals. The Galva, Sac, Primghar, and Marcus soil series were mapped on the farm.

Soils in the Galva and Sac series are classified with the Brunizem great soil group. They have a medium textured, very dark gray to very dark grayish brown surface horizon and a medium textured B-horizon that is dark brown or dark brown to olive brown in color. The Galva and Sac soils differ primarily in thickness of loess over Iowan or Tazewell till. In the Sac series the loess is from 10 to about 36 inches thick, and in the Galva series the loess is greater than 36 inches thick.

The Primghar soil series is classified with the Brunizem great soil group. The Primghar soils have a medium textured, black colored surface horizon and a B-horizon that is medium textured and mot-

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tled with dark grayish brown and olive brown to olive colors. They have developed from loess of about 40 to 80 inches thick.

Soils in the Marcus series are classified with the Wiesenboden great soil group. They have a medium textured black A-horizon and a B-horizon that is medium to fine textured and olive gray to olive in color. They have developed from loess of about 40 to 80 inches thick.

No profile data are available for these series from the experiment field, but data on a Marcus profile from Clay County has been presented by Wilson et al. (1946), on a Sac profile from Dickinson County by Riecken et al. (1947), and on several Galva profiles in northwest Iowa by Foth and Riecken (1954). These series, as well as the Primghar series, have been described briefly by Simonson et al. (1952).

In the preparation of the soil map, subdivisions were made in the four series mapped. Two variations based primarily on the color of the subsoil were separated in each of the Galva, Primghar, Marcus, and Sac series. In addition a variation was separated in the Sac series based on loess thickness. The color of the surface horizon and the color of the subsoil are listed in table 1 for each of the units mapped.

The variations in the Galva series were designated as G and G-P with variation G-P considered to be an intergrade toward the Primghar series. The variations in the Primghar series were designated as P and P-G. Variation P-G was considered to be an intergrade toward the Galva series. The variations in the Marcus series were designated as M and M-P with M-P considered to be an intergrade toward the Primghar series. The variations in the Sac series were designated as S, S-S and S-P. Variation S-P was considered to be an intergrade toward the Primghar series. Variations S and S-S were separated on the basis of loess thickness. The loess was 10-20 inches thick in variation S-S and 24-36 inches thick in variation S.

Relation of Modern Surface to the Tazewell Till Surface

In figure 1 a contour map of the modern surface is superimposed on a contour map of the Tazewell till surface. The contour intervals are two feet with the highest contour line of the modern surface being arbitrarily set at 110. Parts of the contour lines of the Tazewell till surface are dotted. These dotted lines represent areas where the true relative elevation of the till surface is not known. In these areas it is known that the till occurs at a depth of at least 50 inches below the modern surface. The lines are drawn on the basis of the till surface being 50 inches below the modern surface. If the depths were known, the dotted contour lines would be moved up the slope.

Table 1

Color of the Surface and Subsoil Horizons for the Soil Units Mapped on the Galva-Primghar Experimental Farm

Map Symbol	Soil Series	Color of Surface Horizon	Color of Subsoil
S	Sac	Very dark gray to very dark grayish brown	Dark brown
S-S	Sac	Very dark gray to very dark grayish brown	Dark brown
S-P	Sac	Very dark gray to very dark grayish brown	Dark brown to olive brown
G	Galva	Very dark gray to very dark grayish brown	Dark brown
G-P	Galva	Very dark gray to very dark grayish brown	Dark brown to olive brown
P-G	Primghar	Black to very dark gray	Dark grayish brown and olive brown
P	Primghar	Black	Dark grayish brown and olive
M-P	Marcus	Black	Olive gray
M	Marcus	Black	Gray

Thus, the Tazewell till surface is at least somewhat more irregular than the contour lines indicate.

As shown in the contour map of the modern surface, the high area occurs in the north central part and a divide running north and south roughly bisects the farm. The west half of the farm has a series of drainageways and interfluve ridges that decrease in longitudinal gradient in a westerly direction. The east half of the farm also has several interfluve ridges and drainageways that decrease in longitudinal gradient.

The slope gradient on the modern surface is not pronounced in any area, varying from around ½ to 5 percent. In general, the east half has somewhat less slope gradient than the west.

A comparison of the contour map of the Tazewell till surface to the modern surface in figure 1 and the cross-sectional diagram of the two surfaces in figure 2 indicates that the ridges and drainageways occur at approximately the same location on both surfaces. The primary difference between the two surfaces is that the Tazewell surface is more irregular. In general the loess is thinnest on the interfluve ridges and thickest in the drainageways. The thickness of loess on

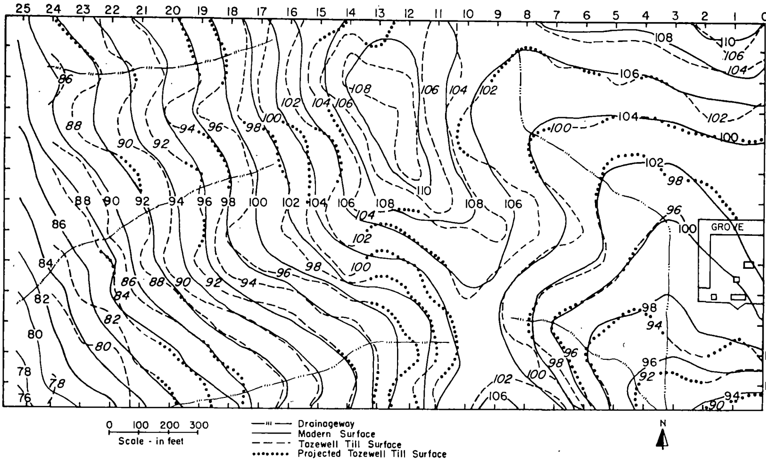

Figure 1. Topographic map of the modern and Tazewell till surfaces on the Galva-Primghar Experimental Farm.

much of the ridges is about 2½ to 3 feet, while in the drainageway the thickness is 3½ feet or greater.

The contour map of the Tazewell surface with well defined drainage channels as is shown in figure 2 indicates that a drainage system had developed on the till surface prior to loess deposition.

No evidence of soil development was observed in the Tazewell till. In most observations made on this tract the loess was underlain by calcareous till or drift. The loess-till boundary was abrupt and relatively distinct. Pebbles too large to sample with the 1½-inch sampling tube used in this study were encountered in many of the borings a few inches below the loess-till contact, indicating the possible existence of a pebble band on the Tazewell surface.

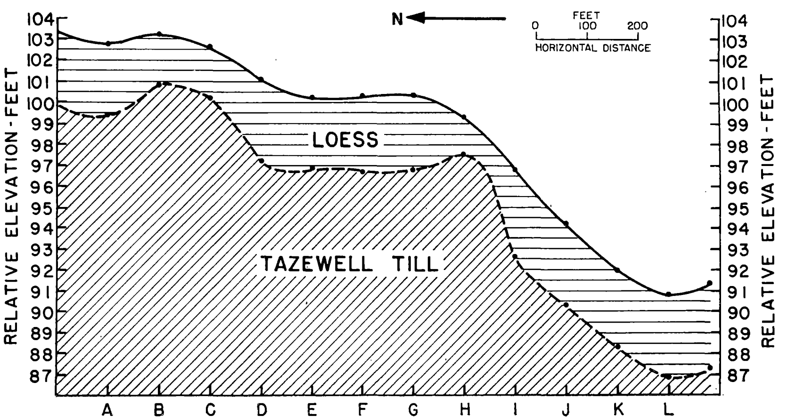

Figure 2. North-south transect at the 1700-foot interval of the Galva-Primghar Experimental Farm showing the relationship of the modern and Tazewell till surfaces.

Soils and Topography

The moisture regime under which soils develop is frequently reflected in the soil profile characteristics. On this tract the Galva and Sac soils have a brown colored B-horizon and are considered to be naturally well-drained (Soil Survey Staff, 1951). The Primghar soils have dark grayish brown and olive colors in the B-horizon. These colors are considered as indicative that drainage or aeration conditions are imperfect. From the gray color of the Marcus subsoil it is intepreted here that the soil has been wet for long periods during the time the soil developed.

As is shown in figure 3, the Galva and Sac soils occupy the highest elevations on interfluve ridges on slopes with a convex vertical curvature and slope gradients of 2-5 percent. These areas receive a minimum of runoff from other areas and occur in positions where runoff and evaporation presumably are at a maximum.

The Primghar soils occur either at lower elevations or on gentler slopes than do the Galva soils. The slope gradient ranges from about 1 to 3 percent, and generally have a concave vertical curvature. The sloping Primghar soil areas commonly receive some runoff water from the Galva-Sac soil areas. The Primghar soils, therefore, have developed under a slightly more moist environment than have the Galva soils.

Marcus soils on this tract have developed only in areas of gentle relief that have received some runoff water from higher lying areas. The G-P and P-G areas occupy intermediate positions on the landscape and are intermediate in soil properties between the Galva and

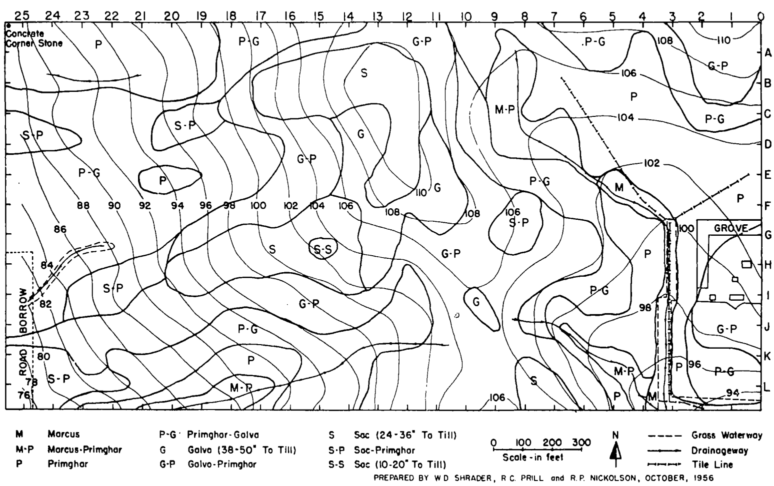

Figure 3. Soil and topographic map of the Galva-Primghar Experimental Farm.

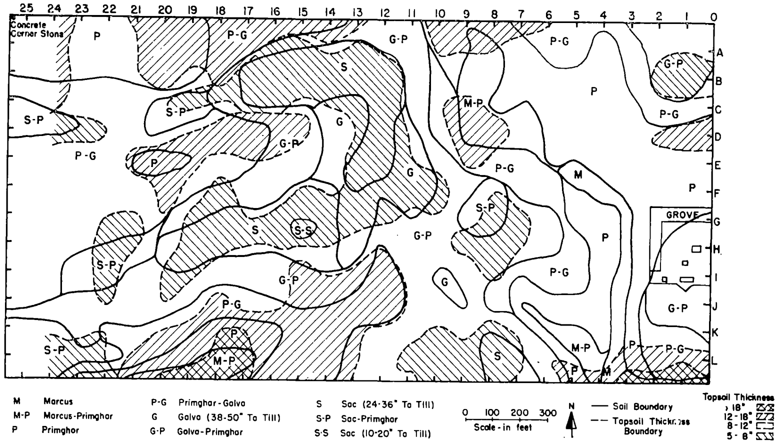

Figure 4. Soil and topsoil thickness map of the Galva-Primghar Experimental Farm.

Primghar soils. The M-P areas occupy like positions between the Marcus and Primghar soils and are intermediate in soil properties.

A generalized map showing topsoil thickness is presented in figure 4, and the average and the range in topsoil thickness for the different soil mapping units are presented in table 2. As shown in figure 4, areas where the topsoil is from 5-8 inches thick generally occur on the interfluve ridges. Galva variation G and the Sac variations (S, S-S, and S-P) are restricted essentially to these ridges. The topsoil thickness of these soils averages from 7-8 inches, somewhat less than for the other soils on the farm. Soils that were classified as Galva variation G-P occur on slope positions below the Sac and Galva variation G soils and have an average topsoil thickness of 10 inches. The Primghar and Marcus soils which occur in slope positions below the Galva variation G-P soils have a topsoil thickness of 12 inches or more.

These areas of shallow topsoil thickness on the interfluve ridges occupy slope positions of greater slope gradients and more convex

Table 2
Average Topsoil Thickness and Range in Topsoil Thickness for the Soil Units Mapped on the Galva-Primghar Experimental Farm

Map Symbol	Soil Series	Average Topsoil Thickness	Range in Topsoil Thickness
S	Sac	7″	5-10″
S-P	Sac	7½″	5-12″
G	Galva	8″	5-11″
G-P	Galva	10″	6-20″
P-G	Primghar	12″	6-18″
P	Primghar	12″	7-20″
M-P	Marcus	15″	9-25″
M	Marcus	20″	14-25″

vertical curvature than other parts of the farm. These areas receive a minimum of runoff water from other areas and occur in positions where runoff and evaporation are probably also at a maximum. Thus, these areas presumably would be less favorable for vegetative growth and more susceptible to geologic and accelerated erosion. Either or both of these factors would favor thinner topsoil thickness in these areas as compared to other areas on the farm.

Summary

A study of the relationship of topography to loess thickness on the Galva-Primghar Experimental Farm showed that in general the loess was thinnest on the interfluve ridges and thickest in the drainageways. The modern surface is slightly more uniform than was the Tazewell till surface just prior to loess deposition. An established drainage system had apparently developed on the Tazewell surface prior to loess deposition.

A study of the relationship of soils to topography indicated that variations in the loess-derived soils reflect the moisture regime under which they developed. The well drained Galva and Sac soils generally occurred on the interfluve ridges where a minimum of runoff water is received from other areas and where runoff and evaporation are at a maximum. The more poorly drained Primghar and Marcus soils occurred in areas of more gentle relief that receive runoff water from surrounding areas. The topsoil was thinnest on the soils that occurred on the interfluve ridges and thickest on the soils that occurred in the drainageways.

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