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The Color of Soils in Relation to Organic Matter Content

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The Color of Soils in Relation to Organic Matter Content

By P. E. Brown and A. M. O'Neal, Jr.

The color of soils has long been considered to indicate to some extent, at least, their fertility. For centuries farmers in the humid regions have been accustomed to select their land very largely on the basis of color. Dark colored soils have been preferred because experience has shown that such soils are usually more productive than light colored types. But just what the relation is between the color of soils and their fertility or crop-producing power has never been determined. It has been assumed that the organic matter or humus content, which is mainly responsible for the color of soils, has a fertility value. It has been believed also that the temperature, aeration, and moisture content of soils bear a direct relation to their color and content of organic matter and hence to their fertility. The actual relation of color to chemical composition, however, has never been studied in detail, although it has been generally understood that dark-colored soils, with more organic matter, naturally contain more nitrogen and organic carbon.

The purpose of the work reported in the following pages was to study the color of soil types and soil series as mapped by different men in various counties in Iowa and correlate their color descriptions with the chemical content of carbon and nitrogen.

The classification of soils by the Bureau of Soils in its soil survey work is based very largely on color. Soil series may be distinguished in part at least on a color basis and the official descriptions prepared by the Bureau prescribe a certain color or range of color for a series. In their survey reports, however, the field men are expected to describe the colors of the soils in detail, giving the range of variation in color and the predominating tint. This is a rather difficult task and different men may have a somewhat different conception of color. There are no color standards to go by. It has become a comparatively simple matter to determine textural differences in the field, but it is very difficult to fix colors with any degree of certainty. Eventually it is hoped that color standards will be worked out and adopted and the mapping and correlation of soils in the field will then become a much simpler and more accurate operation.

It is of interest to know how the descriptions of the same soil types are given by various field men working in different counties. How closely do ideas of color coincide? What are the variations
in color which are permissible for a soil type? Do the descriptions given reflect more the personal equation than an actual variation in the predominating soil type color in different counties? These are questions on which the studies reported in this bulletin throw some light. Correlating the color differences with the chemical composition will show, or at least indicate, how closely the field man’s description of the soil type represents its fertility condition, its content of organic matter and nitrogen.

**EXPERIMENTAL**

The soil survey work in Iowa has been under way for eight years and about two hundred soil types have been mapped in the state. Some types, however, occur in large areas and are found in many counties. The surveys in different counties are made by different men and the descriptions of the soils are written by the surveyor. Material is at hand, therefore, for a comparison of the color descriptions of the same type of soil in various counties. All the soils have been analyzed for total nitrogen and organic carbon by the usual methods and hence these data may be utilized to determine whether or not there is any relation between color descriptions and content of nitrogen and carbon, and also to learn what the variations are in amounts of these constituents in the same soil type, in other words the range of color versus the range of nitrogen and carbon content.

All the soil types mapped cannot be checked up for these comparisons so those types have been selected which have been mapped in a number of different counties and which will provide representation for the most important textural differences in soils.

**THE SOURCE OF DATA**

The color descriptions are those given by the field men as published in the Bureau of Soils reports and the Iowa soil reports. In some types there are subsurface layers which are described separately, but in many of the types the surface and sub-soil descriptions are the only ones which are given. Usually the two soil horizons are all that are recognized and two color descriptions are all that can be given.

The chemical analyses were made by the usual methods and the results expressed as pounds per acre of surface soil, subsurface soil, or subsoil, representing the samples taken to the three depths, 0–6½", 6½–20" and 20–40". Where distinct subsurface layers are not recognized in the color descriptions, the results for the surface and subsurface analyses are averaged, as in most of such cases, the surface soil extends to about 20 inches. To this practice the Carrington loam is the only exception and with this type the surface soil analyses only are
given. Where the subsurface layer is described separately the analyses are considered separately. The tables showing the analyses of the soils are not given, but plates have been prepared from the tables and all the results are shown graphically.

The results of the analyses are the averages obtained from all the samples of the particular type taken in an individual county.

THE RESULTS FOR CARRINGTON LOAM

The results for the Carrington loam are shown in fig. 1 for the surface soil and the subsoil. This type has been mapped in 13 counties and six descriptions of the surface soil are given as dark-brown to black, two as dark-brown, and one as black, while four are given as dark grayish-brown to dark brown, or in other words indicating a grayish tinge to the color. The subsoils are mostly yellowish-brown, two are brown and in several cases the descriptions indicate a predominance of a yellow color. Quite evidently the variations in color given in the descriptions of the surface soil represent the ideas of the field men on the predominating color of the particular type in the county, but there is little relation of color to the carbon and nitrogen content. The sample from one county described as black does show a higher content of organic carbon than the other samples, but there are some other wide variations in carbon which do not show in the color descriptions.

In the subsoil there is even a wider separation between the analyses and the color descriptions and there is apparently no relation whatever. The yellow-brown shades are of course more difficult to describe and place and the personal equation is undoubtedly more important here than in the case of the surface soil. The variations in descriptions of surface soil may be traced to the seasonal conditions, as in dry seasons, particularly, soils are apt to be described as having a grayish tinge.

The very evident need of color charts by which the field men could determine the color, is shown by these results. Apparently the range of color for the Carrington loam may be dark grayish-brown to black while the subsoil may range from light yellow to brown. This range is wider than that allowed in the official descriptions given by the Bureau of Soils for the type and the question arises whether the use of color charts by the men in the field with strict care taken to determine color at a certain moisture content would not largely reduce the description variations.

It is interesting to note the relation of the nitrogen to carbon in this soil as it occurs in various counties. The ratio is almost the same in all cases except one. In one county the ratio is very wide but in all other cases it is about 1 to 12 or 13 and it
FIG. 1.—CARRINGTON LOAM.
would seem that in this soil type the organic matter is undergoing decomposition at a normal and quite satisfactory rate. It will be interesting to note how this agrees with the results in other soil types of similar color. It may be seen also that when the subsoil analyses are considered, the nitrogen-carbon ratio is extremely variable in the different samples and there is no relation to color. In general, however, the ratio is narrower than in the surface soil.

THE RESULTS FOR CARRINGTON FINE SANDY LOAM

The results secured on the Carrington fine sandy loam are shown in fig. 2. This type has been mapped in seven counties and the color descriptions are quite as variable as in the case of the loam of the same series. In the surface soil the color in most cases is described as containing some gray, altho the soil is usually described as dark. There is no relation of the color descriptions to the content of organic carbon and nitrogen. In the subsoil, the color variations are much the same as in the loam. Here, too, there is no relation to the nitrogen and carbon. In the surface soil the ratio of carbon to nitrogen is quite constant, but this is not true in the subsoil. The ratio is such that decomposition should be going on very satisfactorily. Comparing fig. 2 with fig. 1, it is seen that the nitrogen and organic matter are lower in the fine sandy loam than in the loam. This is attributable to the texture of the soil, and the fact that the color descriptions more generally show a grayish tinge would seem to show that this lower plant food content is reflected to some extent in the color.

It is interesting to note also that there is some relation to locality. For instance, in Clinton and Linn counties both types of the Carrington are lower in nitrogen and carbon while in Clay and Marshall counties the content is larger. The color range for the fine sandy loam is from light grayish-brown to black, while with the loam it was from dark-grayish-brown to black. In the subsoil the fine sandy loam ranges from light yellow to dark-brown while with the loam the range is from light yellow to brown. It is further evidenced that the description of the series is too narrow to cover the field variations.

THE RESULTS FOR THE CARRINGTON SILT LOAM

The studies on the Carrington silt loam appear in fig. 3. This is a third type of the same series and has been mapped in seven counties. The range of color in the surface soil is from yellowish-brown to black, but in most cases the description mentions a grayish tinge. The color range is not very different, therefore, from those given for the other two types. In the subsoil the color ranges from brownish-yellow to dark brown, coming
FIG. 2.—CARRINGTON FINE SANDY LOAM.

FIG. 3.—CARRINGTON SILT LOAM.
close to the range found for the other types of the series. These results emphasize the significance of having a wider description of the Carrington series in order to include field variations. As with the other types, there is little relation of the color descriptions to nitrogen and carbon content; in fact, some of the samples which are described as the darkest are the lowest in these constituents. The ratio of nitrogen to carbon is not quite so constant as was the case with the loam and the fine sandy loam, but it is even wider in several cases and hence the decomposition of the organic matter should be proceeding satisfactorily.

The three types of the Carrington series are similar in this respect, altho they vary in content of nitrogen and carbon. The silt loam averages somewhat higher than the loam while the fine sandy loam is quite a little lower.

The personal equation is certainly very important in giving the color descriptions of the same type in different surveys. Standard color charts would undoubtedly serve to bring about more uniformity in this respect. There seems to be little evidence of a relation of color to content of carbon and nitrogen, but these constituents occur in varying amounts in different counties. The silt loam is higher in these plant foods in Clay county just as in the case of the loam and the fine sandy loam. It is lower in Clinton and Linn counties, just as was true with the other types. Hence there seems some relation between the amount of nitrogen and carbon in soils of the same type and the locality.

Figs. 4, 5, 6, 7, 8, 9 and 10 give the results for the Clinton silt loam, the Grundy silt loam, the Tama silt loam, the Marshall silt loam, the Muscatine silt loam, the Webster loam and the Webster silty clay loam. In the first two of these figures the colors and chemical analyses are shown at three depths instead of two, while in the others the figures for the nitrogen and carbon are the averages of those secured at the surface and subsurface, or 0–20". These soils studied are all prominent upland types and except for the two Webster soils are all loessial in origin.

THE RESULTS FOR CLINTON SILT LOAM

The Clinton silt loam has been mapped in 16 counties and hence a rather complete study of the descriptions of this type is possible. The surface soil variations in color are quite wide. In fact, there are no two descriptions alike. The Clinton is a light colored type and the grays, yellows and buff colors are more difficult to describe. Thus the descriptions of field men vary widely. Several of the descriptions were made by the same men working in different counties and their ideas of the color of the soil were not fixed. But the variations may reflect the conditions in the county or the seasonal conditions or may merely
FIG. 4.—CLINTON SILT LOAM.
depend upon the personal equation. Which factor controls is difficult to say, but it is certain that standard color charts would eliminate the groping about for adequate descriptions which is shown in the long worded color descriptions.

Conditions are a little better in the subsurface where light-brown seems to be the favorite. In the subsoil a few agree, but the variations are still wide. This type ranges from ashy gray thru yellowish-brown and grayish-brown to brown in the surface soil. In the subsurface it is described as brownish-yellow and thru several variations up to brown while the subsoil ranges from yellowish-gray to brown.

As with the Carrington soils, there seems little evidence of any relation of color to content of nitrogen and carbon. The total content of these constituents is much less, but there are variations shown in the figure which are not reflected in plant food content at all. No relations appear in the subsurface soil and subsoil. The ratio of nitrogen to carbon in this type was quite variable and in some cases the ratio is too narrow for the best decomposition. Usually, however, the two constituents are related in about the same way in all the samples. The soil needs organic matter, especially active organic matter and these results bear out the field observations. The subsurface soil conditions are more extreme and the ratio of nitrogen to carbon there is extremely poor. The subsoil conditions are quite variable and the ratio of nitrogen to carbon is not at all uniform.

Comparing these results with those secured with the Carrington loam, they lead to the conclusion that the lighter colored types are more difficult to describe than the darker colored ones and they emphasize the value which would be derived from the use of color standards and color charts. The range of color for soil series is not wide enough in the official descriptions, but the terminology which is employed by the writers is much too cumbersome and verbose for clear descriptions. Comparing the results with those of the Carrington silt loam, it is evident that the content of nitrogen and carbon is lower than with that type and this difference is reflected in the color description which is lighter.

THE RESULTS FOR THE GRUNDY SILT LOAM

Fig. 5 shows the results for the Grundy silt loam. This type has been mapped in nine counties and it is a variable type from the standpoint of the subsurface soil. The surface descriptions are remarkably uniform. With one exception they are dark brown to black or nearly black. Only one surveyor includes dark gray. In the subsurface the descriptions are wide, as the soil often has a gray layer or a suggestion of a gray layer, and
FIG. 5.—GRUNDY SILT LOAM.
the field man's description shows where that gray layer is more common. In the subsoil the range of color is also wide, including bluish-gray, yellowish, drab, brown, etc. Either the subsoil of this type is unusually variable or else the colors which occur are especially difficult to describe and interpret. Color standards would undoubtedly aid materially in describing the subsoil of this type.

In spite of the close similarity in the surface soil color descriptions, there is a wide variation in carbon and nitrogen content. Apparently there is no relation here. In the lower layer quite variable amounts of nitrogen and carbon occur, but there is no relation to color in these cases. The samples given the darkest color descriptions occasionally show the smallest amounts of carbon and nitrogen, while those which are described as light in color show a large content of these constituents.

Evidently the chemical analyses of the soils show variations in them which do not appear in the color descriptions. The range of color in relation to the total amount of carbon and nitrogen cannot be calculated with any degree of accuracy at the present time from the data available. Later studies on a larger number of samples may make this possible.

The relation of the carbon to nitrogen in the Grundy silt loam is indicated to be wide and this wide ratio leads to the conclusion that there will be a satisfactorily rapid production of available plant food. The ratio is fairly constant in the different samples of the surface soil. Only in one county is there apparently an abnormal condition. In the subsurface soil and subsoil there are variations in the ratio which may reflect the variable character of the lower soil layers and may also be considered to explain the wide range in color descriptions.

This type is very much better supplied with carbon and nitrogen than the Clinton silt loam and the organic matter present is more valuable apparently. It is much more uniform in surface soil color which would indicate again that darker colored soils may be more accurately described by the field men.

THE RESULTS FOR THE TAMÁ SILT LOAM

The results for the Tama silt loam, surface and subsoil, are shown in fig. 6. The nitrogen and carbon results as shown for the surface soil are the average of the surface and subsurface (0-20").

The color descriptions of the surface soil are mostly given as dark brown, five out of ten being given in that way. Most of the other descriptions, however, include dark brown, three indicate that a grayish tinge was sometimes noted, and one a yellowish tinge, only in one case is a light brown color mentioned. The
FIG. 6.—TAMA SILT LOAM.
range of color for the type would be from light brown thru grayish and yellowish-brown to dark brown and black. One description includes black. In the subsoil brownish-yellow seems the favorite term, but there are several variations from this description. One description is dark-brown and two others do not contain yellow in the description. The range of subsoil color of the type would be from brownish-yellow to dark-brown. It seems again that when yellow occurs in the soil it is more difficult for the men to describe the color and they use many terms in an attempt to give a complete description.

The variation in carbon and nitrogen content in the different samples of this type are extremely wide and there is no relation to the color description, either in the surface soil or in the subsoil. The term dark-brown seems to apply when the carbon content goes from over 100,000 pounds down to less than 50,000 pounds. Perhaps the color description is not complete enough, but it seems more likely that the chemical composition of the soil is much more accurately determinable than the color description can hope to be. Large amounts of organic carbon do not seem to modify the color of some soils, at least not in certain cases.

In the subsoil the conditions are much the same. Wide variations in nitrogen and carbon do not correspond at all with the color descriptions. Lighter colors seem to show more carbon as often as less. Carbon content variations of many thousand pounds per acre do not seem to exert an appreciable effect on the color descriptions—at least in most cases. Occasionally a light color and a low carbon content are found occurring together. Just how wide variations may occur before the color is affected will probably depend on the particular soil type. Later work with more accurate color descriptions may aid the solution of this problem.

The ratio of nitrogen to carbon in this soil is not nearly as constant as in the types discussed earlier. The surface soil shows some wide differences in this ratio, in a few cases it goes as low as 1 to 10, but in most cases it is nearer the desirable ratio of 1 to 12 or 13. Apparently in most instances the Tama silt loam is well supplied with easily decomposable organic matter. In the subsoil the ratio is not so good but this is the case generally in subsoil samples and the conditions in the Tama subsoil are about the same as in other loessial subsoils.

THE RESULTS FOR MARSHALL SILT LOAM

Fig. 7 shows the results for the Marshall silt loam. This type has been mapped in four counties only so that the comparisons are not very complete. The surface color descriptions are fairly uni-
form although some variations appear in the wording. The range of color seems to be from brown to black thru a dark grayish-brown. In the subsoil the color varies from yellow to brownish. Again it seems that the yellow colors are more difficult to describe satisfactorily and uniformly. There is no relation of color description to nitrogen and carbon content. In fact, where the color of the surface soil is described as the darkest, there is the least amount of these constituents. The same is true of the subsoil. The variations in these constituents apparently mean nothing from the standpoint of color in the case of this soil type.

The nitrogen carbon ratio is extremely variable in the different samples of surface soil and in the sample from Sioux county the nitrogen content was abnormally high and appears above the carbon on the charts. The organic matter in this soil type is apparently not in as good a state of decomposition as it should be and the value of organic matter when applied to the Marshall silt loam is explained at least in part. Comparing these results with those secured for the Tama silt loam in fig. 6, a soil whose surface color is very much the same, it seems that the content of organic matter runs much lower. Hence, again it is evident that wide variations in chemical composition are included in common soil color descriptions.

THE RESULTS FOR MUSCATINE SILT LOAM

The Muscatine silt loam results are shown in fig. 8. The color description of this soil is quite uniform for the surface soil, usually being dark brown to black. In one case gray is mentioned and in one other instance black is not given. The range of color, however, in the six counties is dark brownish-gray to black. In the subsoil the variations are wide and the color descriptions are mainly long and indefinite. The terms used are uncertain, the range of color may not actually be as great as indicated but the men seemed to grope blindly for descriptive terms. Dull brown is used. Yellow is mentioned in most cases. Mottlings are indicated. Again it seems that in those subsoils where yellows and grays occur the colors are difficult to name and where mottling is found the difficulty is even greater.

No relation of the nitrogen and carbon content of the soil to color is evidenced in the chart. Variations in amounts of these constituents are not reflected in the color descriptions. The chemical data is more definite. Changes in composition may be rather wide and still not affect the color, especially in the case of dark-colored types. The relation of nitrogen to carbon is somewhat variable, but in most instances the ratio is wide enough to indicate a good state of decomposition. It varies in
FIG. 7.—MARSHALL SILT LOAM. FIG. 8.—MUSCATINE SILT LOAM.
the different samples, however, and without any relation to color. The total amount of nitrogen and carbon in this soil is about the same as in the Marshall silt loam in fig. 7, but the latter soil is known to be more in need of organic matter applications. The average content is a little higher, however, and the color descriptions indicate a darker color, which bears out the results with organic matter on these types in the field. Apparently the nitrogen carbon ratio is of some significance and there are probably also other factors of importance. The carbon content may not vary as widely in different soil types as does the need for organic matter and the response to its application.

THE RESULTS FOR THE WEBSTER SOILS

The results for the Webster loam and Webster silty clay loam, two dark colored drift soils, are shown in figs. 9 and 10. These types have been mapped in four counties only so that the results are not as complete as they might be. With the loam, the color is given in three cases as black, while in the fourth case it is given as very dark brown to black. The subsoil description is extremely variable, including yellow, gray, drab, green and brown colors. Apparently this is a very difficult subsoil to describe, but the range of color may be given as pale yellowish to grayish-brown.

There is no relation of the color to content of nitrogen and carbon in either the surface soil or the subsoil. Again it seems that the chemical composition shows differences which do not appear in the color descriptions, especially in dark colored types. The nitrogen carbon ratio is wide in the surface soil indicating a good state of decomposition. The total amount of organic matter is high as may be seen by a comparison of the figure with fig. 1 for the Carrington loam and this higher content is evidenced in the color description to some extent, but the difference in color is not nearly as great as that in nitrogen and carbon.

With the silty clay loam of the same series the color is not shown to be quite as dark. The descriptions are generally dark brown to black, with a suggestion of yellow in one case. The subsoil is variable, no two descriptions being alike. They include the terms yellow, brown, gray and drab in various combinations. No doubt this variation again indicates the difficulty in describing soils or subsoils of certain combinations of color. There is no relation of color to nitrogen and carbon, wide variations in these constituents occurring in the surface soil where the color is about the same. Similarly for the subsoil the color does not indicate definitely the organic matter content although in one case there is a higher content for a darker color.

The nitrogen carbon ratio is wide in the surface soil so this type like the loam evidently has organic matter in a good state of
FIG. 9.—WEBSTER LOAM.

FIG. 10.—WEBSTER SILTY CLAY LOAM
decomposition. The amount of organic matter is somewhat higher in this type than in the loam but the color is not shown to be quite as dark. The content is much higher than in the Carrington loam but the color is about the same. It seems evident again that the color and organic matter content do not run parallel and it would seem that there must be some other factors involved in the color condition or else the determinations cannot be made as accurately as desirable.

THE RESULTS FOR CALHOUN SILT LOAM

The results for a terrace type, the Calhoun silt loam, are given in fig. 11. These are shown in three parts, as this type is characterized by a typical gray layer. The color descriptions vary widely in the surface soil and also in the subsurface soil and subsoil. In fact, the variations in the surface soil are much greater than in the types previously considered. The color ranges all the way from gray to dark-brown. This may mean more difficulty in giving color descriptions to light colored types, but it must also be noted that the gray subsurface layer will often affect the color of the surface soil. It may be a little nearer the surface in some cases than in others. The subsurface color is variously described but includes light gray, ashy gray, white and buff. The subsoil descriptions are long and complicated. Very great difficulty in getting the right terms to express the color is indicated in the descriptions given. There is no relation of nitrogen and carbon content to the color descriptions in the soil at any depth, but in this lighter colored soil the color descriptions seem to vary as widely as the organic matter content. The nitrogen carbon ratio is narrow in most cases and not uniform in the different samples, indicating a slow rate of decomposition. The value of organic matter additions to this soil is large and this ratio indicates a reason for the effects secured.

THE RESULTS FOR O'NEILL LOAM

In fig. 12 the results are shown for the O'Neill loam. These, too, are shown at three depths and the soil is mapped in six counties. The color descriptions are variable at all three depths, but not so widely as in the case of the Calhoun. The surface soil is darker and the color description can apparently be given more accurately. In the subsurface the color is difficult to describe and includes red and yellow combinations with brown. In the subsoil yellows and browns predominate, the range of color being yellow to brownish. In the surface soil the range of color is dark brown to black, going thru grayish-brown and chocolate brown. There is no relation of color to nitrogen and carbon content at any of the three depths. Wide variations in these constituents occur where the color is very much the same.
FIG. 11.—CALHOUN SILT LOAM.
FIG. 12.—O’NEILL LOAM.

FIG. 13.—O’NEILL FINE SANDY LOAM.
These elements may apparently vary considerably without affecting the color descriptions. The ratio of nitrogen to carbon is narrow and variable and it seems evident that the organic matter in the soil is not in the best state of decomposition. The soil needs organic matter as shown by field experiences and apparently the reason may be found partly at least in the low decomposability of that already present the amount of which according to the analyses is not strikingly low.

THE RESULTS FOR O'NEILL FINE SANDY LOAM

Fig. 13 gives the results for the O'Neill fine sandy loam and like the loam the color is variable. However, the surface soil is lighter on the average, a reflection probably of the lighter texture. The color range of the surface soil is from brown to dark-brown thru grayish-brown. In the subsurface soil light brown to dark brown thru yellowish-brown indicates the range while in the subsoil the color varies all the way from yellow, thru brownish-gray, etc., to brown. There is no relation of the color to content of nitrogen and carbon, wide variations occurring in these constituents which do not show in the color. The ratio between these elements is narrow and variable as in the loam and again the large value of applications of organic matter to this soil is explained in part at least. The color descriptions are not really as uniform as they probably should be and they are somewhat more variable than in the darker soils but less variable than in the lighter colored types.

THE RESULTS FOR WAUKESHA LOAM

In fig. 14, results secured for the Waukesha loam are shown. This type was mapped in six counties and the surface and subsurface analyses for nitrogen and carbon are averaged for the surface soil comparisons.

The color of the surface soil is shown to be dark brown in most instances, one description is black while one is brown to dark brown. The range is, therefore, brown to black. The subsoil descriptions are remarkably uniform. In four cases they show a brown color while in the other cases they are given as light brown or dark brown. The nitrogen and carbon content of these soils is variable without regard to the color description. These elements may occur in widely different amounts, apparently, without showing in the color description. This is a dark colored soil again and the variations in amounts of these constituents are not as readily shown as in the lighter colored types. The ratio of nitrogen to carbon is quite variable but usually wide enough so that it would seem that the organic matter will decompose sufficiently rapidly. The soil is not so very high in organic
matter but is higher than the O’Neill fine sandy loam and a darker color is indicated.

Comparing this terrace type with the very similar type on the upland, the Marshall silt loam, shown in fig. 7, it is seen that there is somewhat less organic matter in the terrace soil altho the color is much the same. The subsoil conditions and color are different in the two types so that no comparisons can be made. The terrace type seems to have a more uniform subsoil condition.
DISCUSSION AND CONCLUSIONS

The data which have been presented are of course far from complete, but it is believed that the results are indicative. While definite conclusions cannot be drawn, certain observations may be made which it is hoped may lead to further study and experimental work along these lines.

In the first place, it may be stated that as for the 14 soil types studied there seems to be little close relation between color and the content of carbon and nitrogen. It is true that the dark colored soils which are described as dark brown to black in general show a higher content of carbon and nitrogen than those soils which are lighter in color.

For example, the Tama silt loam, the Muscatine silt loam and the Grundy silt loam, which are mainly dark brown to black in color, are higher in carbon and nitrogen than the Clinton silt loam, a light colored type. The Marshall silt loam, which is also dark in color, is higher than the Clinton in carbon and nitrogen, occupying an intermediate position both in color and organic matter content. Frequently, however, there are exceptions. Taking the range in color descriptions and the range in nitrogen and carbon content for comparison, however, there is some relation. These types are all loessial in origin, occurring on the upland, and all of the same texture and hence these comparisons seem justifiable.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Color</th>
<th>Carbon</th>
<th>Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tama Silt Loam</td>
<td>Light brown to black</td>
<td>25,000–73,338</td>
<td>2,396–5,179</td>
</tr>
<tr>
<td>Muscatine Silt Loam</td>
<td>Dark brownish-gray to black</td>
<td>36,600–68,400</td>
<td>3,687–5,520</td>
</tr>
<tr>
<td>Grundy Silt Loam</td>
<td>Dark brown to black</td>
<td>43,183–67,300</td>
<td>3,300–4,860</td>
</tr>
<tr>
<td>Marshall Silt Loam</td>
<td>Brown to black</td>
<td>37,307–52,100</td>
<td>3,260–5,326</td>
</tr>
<tr>
<td>Clinton Silt Loam</td>
<td>Ashy-gray to brown</td>
<td>21,820–43,100</td>
<td>1,736–4,060</td>
</tr>
</tbody>
</table>

It will be noted that there is an overlapping in color descriptions and an overlapping in the carbon and nitrogen figures, but the general range is lower in both cases. The highest Clinton silt loam is not as high as the other types in carbon and nitrogen and the darkest colored Clinton is lighter in color than the darkest of the other types. The soils which are sometimes, or usually, described as black in color normally should contain more organic matter. The average figure for such soils would show a higher content of carbon and nitrogen and there is evidently, therefore, some relation.

Comparing the Carrington loam with the Webster loam, both upland drift soils of the same texture, it is evident that the latter will average higher in carbon and nitrogen and darker in color than the former, although there is a wide overlapping in both cases.
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Color</th>
<th>Organic Carbon</th>
<th>Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webster Loam</td>
<td>Dark brown to black</td>
<td>65,880–86,948</td>
<td>4,792–6,897</td>
</tr>
<tr>
<td>Carrington Loam</td>
<td>Dark grayish-brown to black</td>
<td>19,160–66,452</td>
<td>1,237–5,553</td>
</tr>
</tbody>
</table>

Here again there seems some relation between soils of different series, altho the color differences in this case are not wide. Many samples of Carrington loam are dark brown, in fact, most of them are so described while most of the Webster samples are black. Thus the comparisons are really more definite than is apparent when merely a range of color is considered.

Further comparisons might be made which would serve to confirm the above observations. Thus a comparison of Carrington fine sandy loam with Carrington loam would show the former lighter in color and lower in carbon and nitrogen. Here, of course, the types are of different texture so that the results may be explained partly on that basis. The O’Neill loam averages somewhat darker in color than the Waukesha loam, both terrace types and is higher on the average in carbon and nitrogen. The Calhoun silt loam is lighter in color than the Grundy silt loam and darker than the Clinton and the figures for carbon and nitrogen are intermediate between the others.

Thus, it seems that there is some relation of color to organic matter content, at least when averages are considered.

Beyond this rather rough comparison, however, it is not possible to go. A general consideration of all the data shows that the color descriptions are not as fine as the determinations of carbon and nitrogen. In other words, there may be rather wide differences in amounts of these constituents present which would not show at all in color descriptions. This is especially noticeable in comparing the results of the different samples of the same type. Thus with the Clinton silt loam a sample from one county, which is described as the lightest in color, has the highest content of organic carbon and nitrogen. Similar instances are noticeable with many of the other types. Occasionally the reverse is true and a dark sample is highest in organic matter. It seems, however, that rather wide variations in carbon and nitrogen do not necessarily influence the color descriptions. This is particularly true when samples of the same type from different localities are considered. But it is apparent also in some cases when different types are compared. Thus, the Webster loam and the Webster silty clay loam are both described as dark brown to black but the latter type contains a very much larger average amount of carbon and nitrogen. The difference in texture here may affect the amount of organic matter but it does not seem to influence the color.

The Grundy silt loam is dark brown to black and the O’Neill
loam has the same color description. Both are, however, lower in carbon and nitrogen than the Webster, but the two contain very much the same amounts. The Muscatine silt loam and the Marshall silt loam are about the same in color but the former is higher in carbon and nitrogen. It seems apparent that color and organic matter cannot be compared except in the case of wide differences in the former. Large variations in carbon and nitrogen may show no influence on the color.

There is, of course, another phase to this problem which should be considered and that is the accuracy of the color descriptions as given by the field men. A consideration of all the data given here seems to indicate that these descriptions are not as accurate, comparatively, as they might be. With the dark colored soils there is less difficulty, but when the light colored soils are concerned there is much uncertainty of the definiteness of the color descriptions. In other words, there is opportunity for the personal equation to play an important part in the descriptions. This is a variation which is superimposed upon another variation derived from color sense and also upon a somewhat defective terminology. The adoption of color charts would be of very great assistance, bringing descriptions of soil types into greater uniformity.

It is hoped that a study of soil colors which is now being made may lead to a standard soil color chart. It is desirable also that a definite terminology for soil colors be adopted. When light colored soils are described, there is a futile groping in the dark for the right terms to use to describe them and as a consequence long, verbose, uncertain color descriptions are often given. It would permit of much more certain comparisons of color and organic matter content if color charts and definite descriptive terms were employed. It is only necessary to examine the data given here to see how the surveyor strives to express his idea of the color of the soil and how his description varies from that of another man in another county and even from his own description of the same type in another county.

A further question is involved in this study and that is the range of color which is permissible for soil type separations. It is realized that very fine distinctions cannot be made on the basis of color, but color is one of the most important factors determining the soil type. It is obvious that all precautions should be taken so that the soil color may be read aright. Shall the descriptions be based on field observations or on air-dry typical samples? If the former, then the seasonal conditions may have an effect on the color description. If the latter method is used, how is the field man to describe the soils or give the range of color without collecting and drying a large number of samples? This is a
matter which should be investigated and when methods are fol­
lowed which will eliminate the questions of the accuracy or rather
of the comparability of the descriptions of the samples of the
same type from different areas, then it may be possible to draw
more definite conclusions on the relation of color to organic
matter content.

It is hoped that this report may call attention to some lines
of study which are significant in soil science and which will
enable us at some time to determine what the relation of soil
color is to fertility. For the present it is only safe to say that the
average organic matter content of light colored soils is less than
that of dark colored types; but variations in organic carbon and
nitrogen content in different samples of the same type may or
may not be reflected in the color descriptions as given at present.
Dark colored soils are more readily described than light colored
types and the importance of the adoption of color charts and a
definite color terminology is emphasized to eliminate as far as
possible the personal equation in soil descriptions.