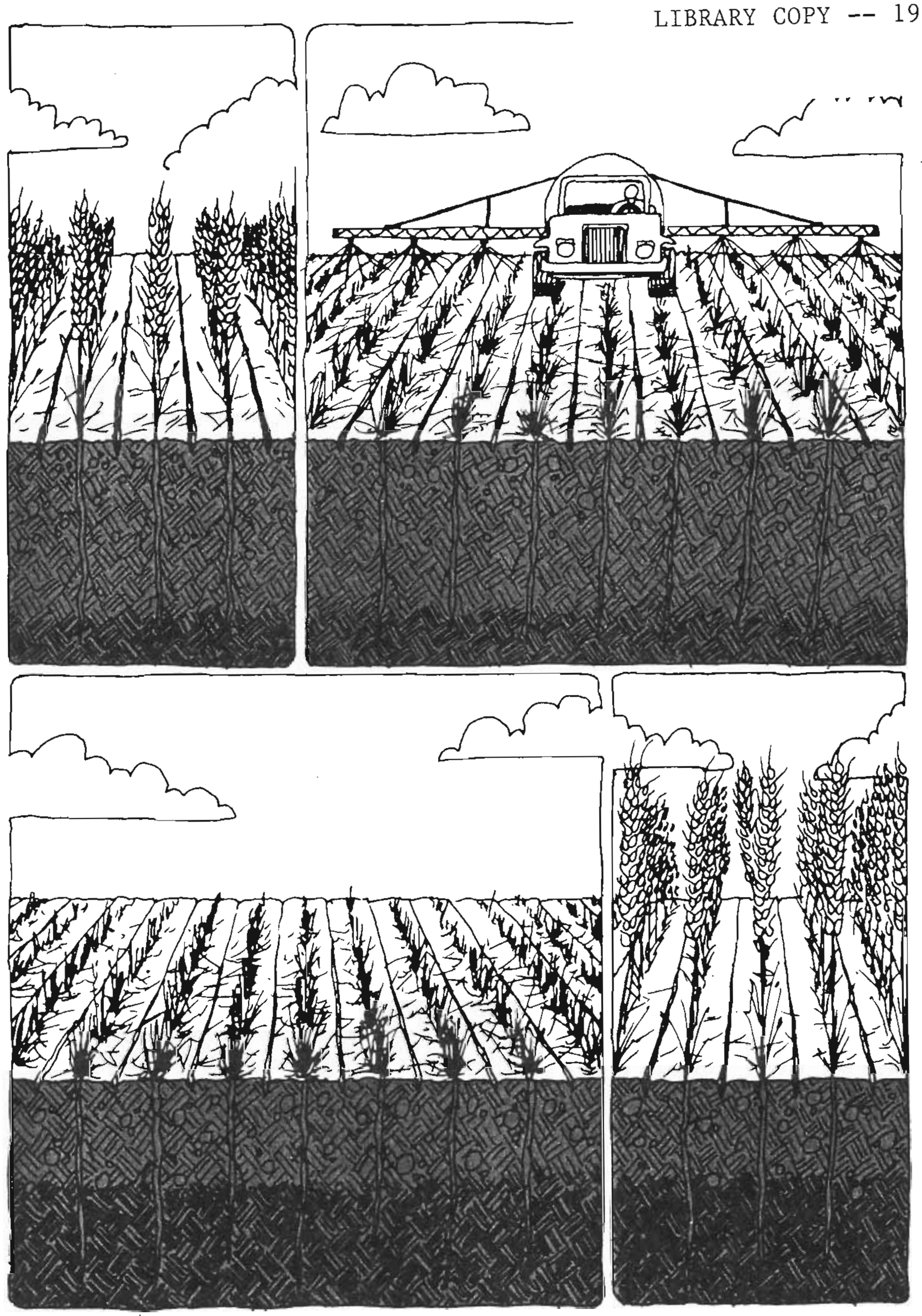

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ATRAZINE CARRYOVER AND ITS SOIL FACTOR RELATIONSHIPS

TO NO-TILLAGE AND MINIMUM TILLAGE FALLOW-WINTER WHEAT CROPPING IN THE CENTRAL GREAT PLAINS

EXPERIMENT STATION

D.E. Smika and
E. David Sharman[1]

ATRAZINE CARRYOVER AND ITS SOIL FACTOR RELATIONSHIPS TO NO-TILLAGE AND MINIMUM TILLAGE FALLOW-WINTER WHEAT CROPPING IN THE CENTRAL GREAT PLAINS[2]

[1]Soil scientist, USDA-ARS, Central Great Plains Research Station, Akron, Colo., and District Conservationist, USDA-SCS, Hugo, Colo.

[2]Contribution from Soil, Water and Air Sciences, USDA-ARS and USDA-SCS.

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INTRODUCTION

Current national trend in farming is toward minimum and no-tillage cropping systems. This is important to Great Plains farmers. To avoid confusion of terms, the following definitions have been provided:

No-tillage is a cropping system whereby the crop seed is placed into soil that has not been tilled since the planting of the previous crop. The seeding operation opens a narrow slot or trench of sufficient width and depth for seed coverage and soil contact. All weed control is with the use of herbicides. Other terms frequently substituted for no-tillage are no-till, zero till, zero tillage, directing seeding and direct drilling. All of these indicate the elimination of such tillage operations as plowing, disking, blading or rodweeding for weed control or the pretense of "seedbed" preparation.

Minimum tillage is a cropping system whereby tillage for weed control between the harvest of one crop and the seeding of the next is restricted to the fewest possible operations, and major weed control is performed by herbicides.

Mechanical tillage is a cropping system whereby all weed control is performed with tillage implements, including plowing, disking and blading with no herbicide usage.

Ecofallow is a cropping system whereby a three-year rotation of fallow-winter wheat-spring seeded crop (corn, sorghum, millet) is used. Weed control between the winter wheat and spring seeded crop is with herbicides while after harvest of the spring seeded crop, herbicide and tillage combinations are used.

Before either no-tillage or minimum tillage can be successful in any farming operation, the concept, necessary changes in philosophy, and performance of operations must be fully accepted and willingly implemented by the operator. Such changes may include different machinery and equipment and familiarization with terms related to herbicides and their application. The no-tillage system almost certainly will require the acquisition of a seeder that can plant in straw amounts in excess of 2,000 pounds per acre.

The introduction of plant growth regulators during World War II led to the initial development of no-tillage and minimum tillage crop production systems. This development in general occurred with row crops in the corn belt (Illinois, Iowa, Nebraska, Missouri, South Dakota, Kansas) of the United States. In the late 1950s and early 1960s research was started on no-tillage and minimum tillage for the production of winter wheat in a wheat-fallow cropping system in the semiarid Central Great Plains. The results have shown that no single tillage system (no-tillage, minimum tillage or mechanical tillage) is best suited for all soil types and soil conditions. However, no-tillage and minimum tillage consistently have shown several advantages over all mechanical tillage systems; these advantages include:

a. improved soil water storage and better seedbed soil water conditions, especially during dry periods;
b. reduction in soil erosion by both wind and water;
c. energy conservation because of fewer trips over the field with high horsepower tractors;
d. soil compaction risk is reduced because the number of trips over the field is decreased;
e. crop planting time can be better regulated to the optimum and not controlled by variation of the weather;
f. machinery size and tractor HP can be reduced to minimize equipment investment, making the system attractive to small operators;
g. reduction in power required to pull equal size implements through nontilled soil as compared with tilled soil;
h. leaves surface soil mellow and friable with minimal crusting;
i. consistently results in increased grain yields of better quality.

The no-tillage and minimum tillage systems are not problem free. Compared to mechanical tillage, some of their disadvantages include:

a. soil temperatures in the spring almost always are cooler, delaying spring growth initiation of the crop;
b. higher producer-managerial knowledge is needed to be aware of soil differences within fields and between fields, weed species and population shifts, fertility needs and crop varieties best suited for each condition;
c. herbicide residue carryover problems have occurred and are more prevalent after cold winters;
d. requires precision application and precise sprayer calibration.

Wide-spread farmer use of herbicides for weed control for minimum tillage fallow in the Central Great Plains first occurred in 1976 when approximately 1 percent of the fallow acres received such treatment. During the 1980-81 fallow period, herbicides were applied on approximately 10 percent of the fallow acres. The predominant residual herbicide used on these acres is AAtrex* (atrazine). The increase in acreage treated with herbicide has increased the incidence of herbicide carryover. Some of the carryover situations have been disastrous to the succeeding wheat crop.

Frequently atrazine carryover occurs in small areas within fields where past management also has resulted in poor wheat stands. These areas can be detected with infrared photography, and when viewed from the air they seldom make up a high percentage of the total acreage in the field. These areas can be treated with lighter rates or different herbicides that do not present carryover problems to minimize the atrazine carryover problem.

METHODS

To identify the soil factors most commonly associated with stand reduction due to atrazine carryover in minimum tillage cropping systems, 57 field sites were selected where 1 pound active ingredient (ai) per acre atrazine had been applied 13 to 14 months before wheat seeding and stand reductions ranged from 0 percent to 100 percent. The soil at each site was mapped, classified and sampled in three locations by 1-inch increments to a depth of 6 inches. Each sample was individually analyzed for pH, percent total N, cation exchange capacity (CEC), total organic carbon, (converted to percent organic matter [OM] by a factor of 1.724) and percent sand, silt and clay.

The previously listed analyses were made because of their importance. The pH is a measure of the acidity or alkalinity of the soil and determines whether positive or negative charges, respectively, predominate in the soil. The nitrogen content of the soil was used to determine the soil's potential for microorganisms, which are important in the breakdown of triazine herbicides. The CEC is a measure of the ability of negative charges on the clay and OM to hold and exchange with positive charged salts and minerals, including triazine herbicides. The OM measurement is an expression of such factors as soil color, nutrient supply and the factors previously listed. The sand, silt and clay particles determine the texture of the soil and is used in classification.

Standard correlation techniques were used to relate pH, total N, CEC, OM and clay to the associated stand reduction and resulted in correlation coefficients of 0.70, 0.05, 0.62, 0.27 and 0.17, respectively. The pH, CEC, OM and percent clay combined accounted for 97.6 percent of the stand reduction. Stand reduction is least sensitive to total N, OM and clay. However, percent clay is one of the characteristics used in classifying a soil; therefore, it was used as the basis for relating the chemical factors to stand reduction.

The soil map with related descriptive information for a soil series will contain a known range of clay contents. This information can be used to identify characteristics where atrazine carryover may occur. These maps are commonly available at Soil Conservation Service offices.

MANAGEMENT GUIDELINES

The relationship between clay content and pH, CEC and OM with curves for various stand reduction percentages are shown in figures 1, 2 and 3, respectively. Also shown in parentheses are the probabilities of obtaining a stand reduction as great as that represented by the curve. These figures provide the herbicide user with guides regarding the stand reduction that can be expected, if the soil texture, pH, OM or CEC is known, and a rate of 1 pound ai-per-acre atrazine is to be used.

Examples of the use of the figures to determine the expected stand reduction are as follows: (1) a soil with 16 percent clay, pH of 7.8, CEC of 30 milliequivalent per 100 grams soil and OM has 0.8 percent estimated stand reductions of 60 percent, 50 percent and 40 percent as depicted by the letter (A) in figures 1, 2 and 3, respectively; (2) a soil with 19 percent clay, pH of 6.8, CEC of 20 milliequivalent per 100 grams soil and OM of 3.7 percent, depicted by the letter (B), has no stand reduction indicated in any of the figures; and (3) a soil with 10 percent clay, pH of 8.3, CEC of 35 milliequivalent per 100 grams soil and an OM of 1.0 percent, depicted by the letter (C), has a stand reduction estimate of greater than 80 percent in all three figures. Organic matter is the most conservative of the three bases used for estimating stand reduction because, as pointed out earlier, the correlation is not high. In this study yield reductions were not obtained until stand reductions exceeded 25 percent.

For each 0.1 pound ai-per-acre reduction in amount of atrazine applied, stand reduction decreases approximately 10 percent. Current label calls for a minimum effective rate of 0.5 pound ai-per-acre atrazine to be applied at the beginning of a 14-month fallow period. Also, the results from this study show that atrazine should not be used when the clay content of the soil exceeds 30 percent (figures 1 and 2). Average annual precipitation for the sites in this study was between 14.1 and 16.0 inches where the performance of atrazine would be expected to remain as found in this study. Where average annual precipitation exceeds 16 inches, and stand reductions of 40 percent or less are expected, each 0.5 inch increase in precipitation would be expected to decrease the stand reduction by 10 percent. Where average annual precipitation is between 12 and 14 inches, atrazine should be used only where soil conditions show estimated stand reductions of less than 20 percent, and the rate of atrazine also should be decreased 0.125 lb ai-per-acre for each 0.5 inch decrease in precipitation. Where average annual precipitation is less than 12 inches atrazine is not recommended for use.

When the conditions of the soil indicate a stand reduction greater than can be tolerated, herbicides other than atrazine can be used. The short-term residual herbicides of Bladex* (cyanazine) and Igran* (terbutryn) can be applied up to 120 days before wheat seeding with minimal carryover problems. Applications of such contact herbicides as Paraquat* (dimethyl-bipyridinium), Roundup* (glyphosate), Banvel* (dicamba) and 2,4-D Ester can be used, depending on weed species present and length of control desired. Tank mixes of some herbicides are

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possible, but the label always should be checked before mixing any herbicides.

New herbicides are becoming available and appear to have a place in the minimum or no-till fallow-wheat cropping system. The herbicide Chem hoe 135* (isopropyl carbonilate) is a recent product on the market and should be considered in controlling volunteer small grain and cool season grassy weeds. The herbicide Glean* (a benzenesulfonamide formulation) is in the trial use stage and offers promise for control of broadleaf weeds. Elanco has a product that appears promising, and others will be available in the future. To keep advised of the status of herbicide availability, commercial applicators, the Extension Service or research institutions should be contacted.

This information will aid applicators and users in determining if atrazine should be used on specific fields, what rate of atrazine to use and options available to provide the weed control necessary in a minimum or no-tillage fallow-cropping system.

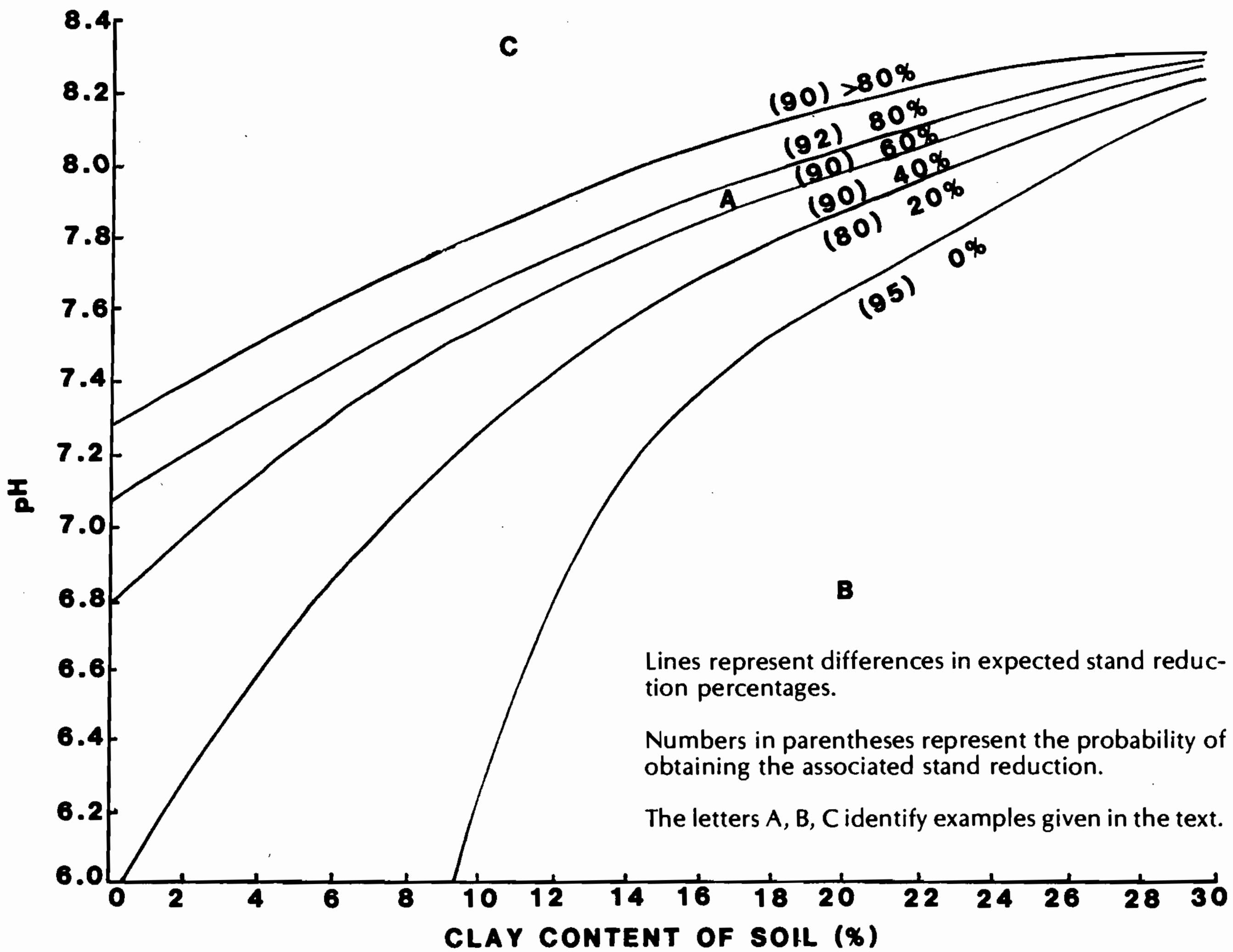

Figure 1. Stand reduction as related to pH and clay content of the soil.

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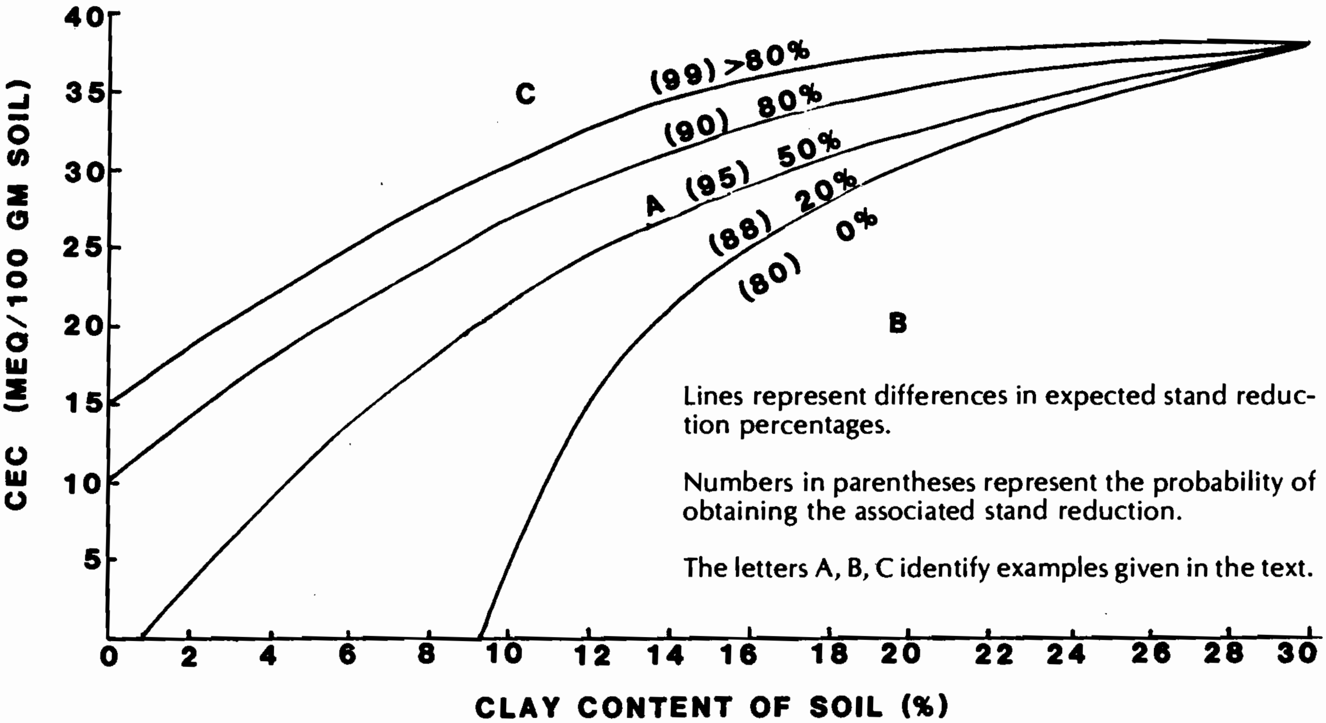

Figure 2. Stand reduction as related to cation exchange capacity and clay content of the soil.

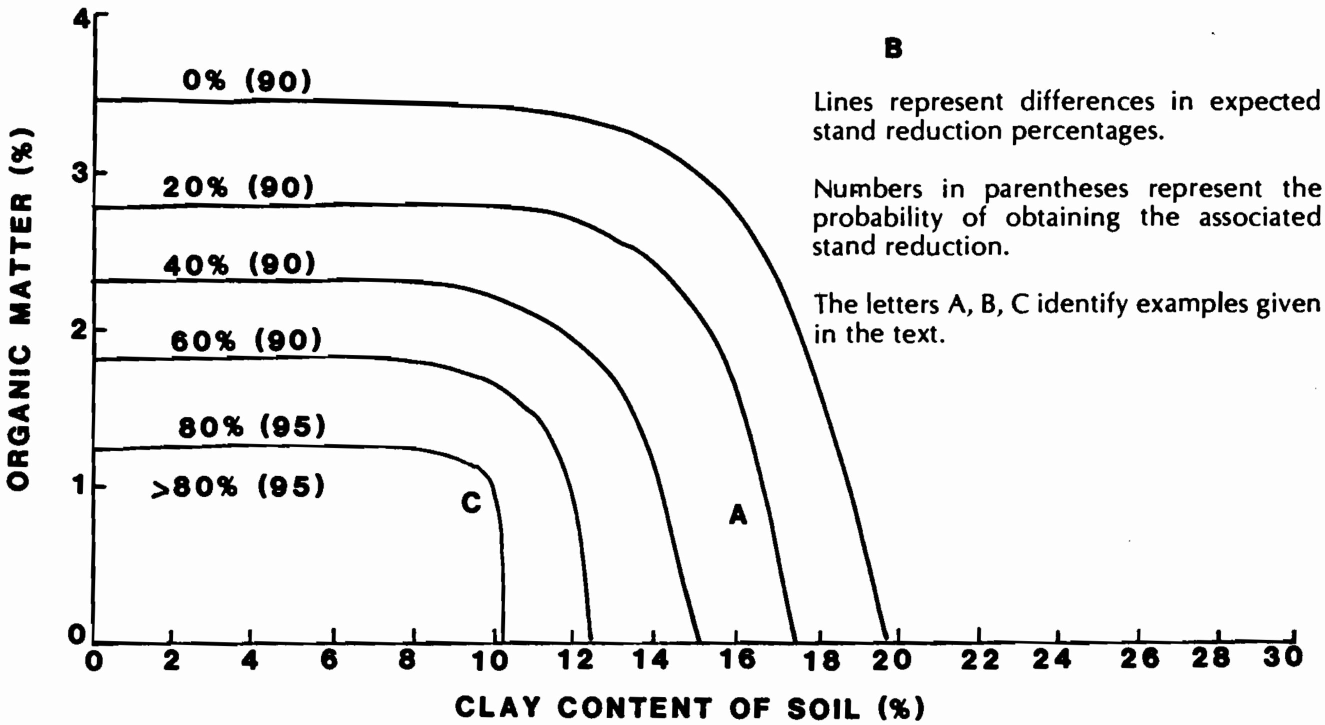

Figure 3. Stand reduction as related to organic matter and clay content of the soil.