NRCS Natural Resources Conservation Service

TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

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NITROGEN LEACHING INDEX FOR TEXAS

INTRODUCTION

The Nitrate Leaching Index (NLI) is an indicator of the potential for nitrate to reach groundwater. Nitrate, because it is water soluble, moves downward as water percolates through the soil. The extent of percolation depends on permeability, pore-size distribution, soil depth to a restrictive layer, artificial drainage, and precipitation amount and distribution over the year. For a given precipitation pattern, excessively well drained soils have a significantly greater leaching potential than less well drained soils. The Texas NLI rates leaching potential based on soil hydrologic group (**Table 1**) and most current 30 year average annual precipitation data for the county.

Table 1 – Soil Hydrologic Groups Soil Hydrologic Group	Description	Infiltration and water transmission rate	Leaching Potential	Runoff Potential
A	Deep, well-drained to excessively drained sands and gravels.	High	High	Low
B	Moderately deep to deep, well to moderately well drained, moderately fine to moderately course texture.	Moderate	Moderate	Moderate
C	May have a restrictive layer, or have moderately fine to fine texture.	Slow	Low	High
D	Mainly clay soils that have a high swelling potential, soils with a permanent high water table, claypan, or have clay near the surface, and shallow soils over impervious material.	Very Slow	Very Low	Very High

Calculating the Nitrate Leaching Index

The Nitrate Leaching Index is the product of the Percolation Index (PI) and the Seasonal Index SI) (Williams and Kissel, 1991): **NLI = (Percolation Index** x **Seasonal Index)**. The Percolation Index is a function of the county annual average precipitation (PA) and soil hydrologic group. Current hydrologic groupings for each Texas map unit can be found in the NRCS Soil Data Mart and Web Soil Survey (WSS) by generating the "Water Features Report".

Under identical precipitation levels, soils with a hydrologic group "A" have the greatest percolation potential while soils of hydrologic group "D" have the least percolation and therefore are least conducive to leaching.

For soils with a hydrologic group that consists of more than one letter (e.g. "A/D", "A/C", "C/D"), its hydrologic group is determined by the presence or absence of adequate artificial drainage. If the field is artificially drained ("adequate" or "excellent") the hydrologic group moves to the first of the two classes. If the field is inadequately drained or not drained at all ("none" or "inadequate"), the second of the two classes is assigned. For soils with a single hydrologic group, artificial drainage does not influence the hydrologic group used. Equations are shown below for users who wish to build these into their own software applications.

Hydrologic Group A: $PI = (PA - 10.28)^2 / (PA + 15.43)$

Hydrologic Group B: $PI = (PA - 15.05)^2 / (PA + 22.57)$

Hydrologic Group C: $PI = (PA - 19.53)^2 / (PA + 29.29)$

Hydrologic Group D: $PI = (PA - 22.67)^2 / (PA + 34.00)$

These equations were derived from Williams and Kissel (1991) and reported by Pierce et al. (1991).

The Seasonal Index (SI) is determined by the Annual Precipitation (PA in inches) and the sum of the fall and winter Precipitation (PW) in inches: $SI = (2 \times PW / PA)^{1/3}$. Due to the variety of crops, growing season lengths and cropping systems (e.g., double and triple crop) that occur in Texas, the fall and winter precipitation period has been customized by crop and/or system to reflect the fall and winter dormant season, or periods with no crops in the case of double or triple crop systems. This customization has been done for the major crops in all counties and regions of Texas.

The complexity of the Nitrogen Leaching Index calculations in Texas has resulted in the need for the development of a planning tool to aid in calculations, **Nitrogen Leaching Index Worksheet TX – Version 4.** The Nitrogen Leaching Index Worksheet is an easy to use spreadsheet which calculates the N Leaching Index value for the major crops grown in Texas. Crops not listed may be manually entered to generate a Nitrogen Leaching Index value. To use the sheet you simply select the county, and enter any additional water from irrigation, select the predominant soil in the field with hydrologic grouping designation and the N Leaching Values are generated.

Management Implications

An NLI below 2 indicates that the potential for nitrate leaching below the root zone is low. An

NLI greater than 10 inches indicates that the potential for soluble nutrient leaching below the root zone is large while NLI's between 2 and 10 are considered intermediate. In order to meet the N leaching requirements of the NRCS nutrient management standard (590), producers are expected to implement conservation systems, practices or management activities if the NLI score for a field is high (>10). Producers are expected to consider the same practices on a case-by-case basis if the NLI rating for a field is intermediate (2-10). Management activities recommended for soils with medium to high N leaching indices include those listed below. These recommendations are based on research done, among others, by Sogbedji and co-workers (2000) and Van Es and co-workers (2002).

All Commercial N Fertilizer Applications

- Initial commercial fertilizer application plans shall be based on a current soil test (not more than 1 year old); soil testing frequency is once every 3 or 5 years, according to Appendix 1 of the TX 590 Nutrient Management Standard. A nutrient budget will be used as a guide in the years between soil tests.

- Total annual nitrogen application for all N Leaching Indices must not exceed the crop requirement by more than 10%, unless NRCS Certified Nutrient Management Specialist approval is given prior to application.

- Total nitrogen applied in any given year shall not exceed the crop requirement for a realistic yield goal based on a soil test recommendation or a nutrient budget. The realistic yield goal is defined as the estimated yield within 125% of highest yield of the last 10 years or in lieu of yield history, consult a Nutrient Management Specialist.

- Nitrogen shall be applied as close to planting as possible. Pre-plant nitrogen application should not precede the normal planting date of the target crop in the FOTG by more than 120 days if incorporated within 48 hours and 30 days if surface applied.

- Manure N application on legumes is acceptable to satisfy the crop requirement.

- NOTE: State regulations for application of animal wastes and other biosolids take precedence over these guidelines. Follow Appendix 1, 2 and 5 of the TX NRCS Nutrient Management Standard 590 and Practice Standard 633 Waste Utilization for NRCS nutrient management and application requirements when animal waste is applied.

- See TX Nutrient Management Standard 590 for additional requirements, supporting conservation practices, and considerations of N management.

Commercial N Fertilizer Application When an Identified Nitrate Leaching Problems Exist

- Follow all appropriate guidance in the management Implications section, plus;

- N will be applied in split applications at a rate not to exceed 100 lb/ac actual N or 50% of the annual soil test recommendation or nutrient budget rate **whichever in greater**, if the N leaching index is 10 or less.

When the area of concern is on coarse textured soils, in recharge areas defined by Texas Commission on Environmental Quality (TCEQ) as sensitive aquifers, or areas defined by NRCS as being frequently flooded or soils with high water tables (not perched).

- Follow all appropriate guidance in the management Implications section, plus;

- N will be applied in split applications at a rate not to exceed 100 lb/ac actual N or 50% of the annual soil test recommendation or nutrient budget rate **whichever is less**, if the N leaching index is 10 or less.

- **See Complete TX Nutrient Management Standard 590 for additional requirements and considerations of N management.**

Other Considerations

- Plant winter hardy cover crops whenever possible, regardless of, but especially when fall manure is applied (e.g., rye, winter wheat, or inter-seed ryegrass).

- Additional soil tests should be considered after years of extremely high or low production. This is ± 30% of the realistic yield goal.

- Plant tissue analysis may be used as part of a complete nutrient management system.

- Even though Appendix 1, 2 and 5 of the TX NRCS Standard 590 determine the maximum application rate for animal waste, any appropriate technique mentioned above may be incorporated into a waste management plan to limit N leaching.

- Deep soil testing to the bottom of the root zone is encouraged any time high levels of N are applied to row crops or forages in humid climates, or where large amounts of irrigation water are applied.

References

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