U.S. Department of Agriculture

Natural Resources Conservation Service

Auburn, Alabama

AGRONOMY TECHNICAL NOTE

AL- 73

September 2014

Nitrogen Leaching Index for Alabama

A Planning Tool to Assess & Manage N Leaching

Non-leguminous crops typically require more nitrogen than Alabama soils provide in a growing season. Fertilizer, manure and legumes can all be sources of nitrogen that are required for economical crop production in Alabama. On the same note, too much available N may result in lower yields, reduce crop quality and become an environmental concern. If soil N as nitrate (NO_3^-) supply is greater than crop demand, the excess NO_3^- may leach and enter ground or surface water. Therefore, a nutrient management approach that utilizes nutrient budgeting, risk assessment and the 4 R's (Right Source, Right Rate, Right time, and Right Place) is warranted in Alabama to reduce economic and environmental risk.

NITROGEN CONCERNS IN THE ENVIRONMENT

Nitrogen is in organic and inorganic forms in soils. As much as 90 percent of soil nitrogen is in the soil organic matter, plant residue and/or animal manure/litter in an organic form. This organic nitrogen consists of proteins, amino acids, amino sugars, or in very complex unidentified substances in advanced stages of decomposition. The soil organic nitrogen, unlike inorganic forms of nitrogen, is not available for plant uptake or leaching.

The majority of nitrogen that is in the soil in an inorganic form is the result of the mineralization of organic material or the result of commercial fertilizer applications.

Organic sources of N are mineralized into the ammonium ion form (NH_4^+). Ammonium is positively charged and is attracted to negatively charged sites on soil particles, as are other cations. It is available to the plants, and will not leach. The N (NH_4^+ form) is converted to nitrate (NO_3^-) soon after its formation or addition as fertilizer.

Negatively charged nitrate remains in the soil solution and moves with soil water. Nitrate may leach out of the root zone when rainfall and/or irrigation water is excessive of plant use plus evaporation. The nitrate that leaches out of the root zone may enter the ground water and negatively affect water quality.

Consequently, in soil where the leaching potential is great, best management practices (BMP) should be instituted to reduce the risk of nitrogen leaching.

NITROGEN LEACHING INDEX CONCEPT

The Nitrogen Leaching Index (NLI) is an indicator of the potential for nitrates 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 greater leaching potential than less well drained soils.

The Nitrogen Leaching Index is the product of the Percolation Index (PI) and the Seasonal Index (SI) (Williams and Kissel, 1991): NLI = (PI x SI). The Percolation Index is a function of the county annual average precipitation (AP) and soil hydrologic group. Current hydrologic groupings for each Alabama map unit can be found in the NRCS

Soil Data Mart and Web Soil Survey (WSS) by generating the "Water Features Report". Table 1 contains the NLI for all four hydrologic groups in all of the counties in Alabama.

Management Implications

An NLI below 2 indicates that the potential for nitrate leaching below the root zone is low. An NLI between 2 and 10 are moderate, between 10 and 20 are moderately high, and greater than 20 indicates that the potential for nitrate leaching below the root zone is high.

All soils in Alabama have an NLI greater than 2 and will require management to reduce the risk of nitrate leaching. In order to meet the N leaching requirements of the NRCS nutrient management standard (590), producers shall apply all nitrogen at the **"right rate"** and the **"right time"** according to the following criteria.

Management Criteria

- **Right Rate**: Total nitrogen applied shall be within 10% on field bases of the ACES recommendation (table 2). If yield potential is significantly greater or less that average, nitrogen rate may be based on "per unit of yield" for some crops. If nitrogen rates are based on "per unit of yield", realistic yield goals must be established based on historical yield data, soil productivity information, level of management, and local research results considering comparable production conditions. Realistic yield goals are often within 125% of a 3 to 5 year average yield.

- **Right Time**: All nitrogen application shall correspond as close as practical with plant nutrient uptake. Nitrogen sources should not be applied more than 30 days prior to planting (annual crops) or 30 days prior to the beginning of the growth cycle (perennial crops). Table 2 lists the "right time" for the major crops in Alabama and should be used as an indicator of crop growth and nutrient uptake. At a minimum, split applications shall be made according to ACES recommendations in table 2. Additional splitting of nitrogen applications can be made to maximize efficiency as long as the nitrogen applied is proportional to the expected growth and nutrient uptake of the crop. Since manure/litter releases nutrients over time, when it is used, two split applications can be made simultaneously on all crops. When applying the last split application of nitrogen to hay, another cutting of hay should be expected during the current growing season and for pasture, another 45 days of grazing should be expected after this last application of nitrogen.

Management Considerations

The following should be considered in all cases regardless on NLI.

- Plant small grain cover crops or over-seed perennial sod with annuals to scavenge residual nitrogen. (In situations where the previous crop did not reach the yield goal, residual nitrogen in the soil is likely.)
- Implement conservation practices to improve soil health and promote plant health and vigor.
- When available use application equipment that utilizes rate controllers, GPS guidance, automatic section control or any combination of all 3 to improve application rate and placement.
- Use variable-rate nitrogen application based on expected crop yields, soil variability, or chlorophyll concentration.

REFERENCES

Mitchell, C.C. and G. Huluka 2012. The Basis of Soil Testing in Alabama. Agronomy and Soils Departmental Series No 324A. Alabama Agricultural Experiment Station. W. Batchelor, Director. Auburn University.

Mitchell, C.C. and G. Huluka 2012. Nutrient Recommendation Tables for Alabama Crops. Agronomy and Soils Departmental Series No 324B. Alabama Agricultural Experiment Station. W. Batchelor, Director. Auburn University.

Williams, J.R., and D.E. Kissel (1991). Water percolation: an indicator of nitrogen- leaching potential. In: R.F. Follet, D.R. Keeney, and R.M. Cruse (Eds.). Managing nitrogen for groundwater quality and farm profitability. Soil Science Society of America, Inc. Madison, Wisconsin. pp 59-83.

Table 1. Alabama Nitrogen Leaching Index. (H=high leaching potential, MH=moderately high leaching potential, M=moderate leaching potential L=low leaching potential)

	------- Hydrologic Soil Group -------					------ Hydrologic Soil Group -----			
	A	B	C	D		A	B	C	D
AUTAUGA	H	MH	MH	MH	HOUSTON	H	MH	MH	MH
BALDWIN	H	H	MH	MH	JACKSON	--	H	MH	MH
BARBOUR	H	MH	MH	M	JEFFERSON	--	H	MH	MH
BIBB	H	H	MH	MH	LAMAR	H	H	MH	MH
BLOUNT	H	H	MH	MH	LAUDERDALE	--	H	MH	MH
BULLOCK	H	MH	MH	MH	LAWRENCE	H	H	MH	MH
BUTLER	H	H	MH	MH	LEE	H	H	MH	MH
CALHOUN	H	MH	MH	MH	LIMESTONE	H	H	MH	MH
CHAMBERS	H	H	MH	MH	LOWNDES	H	MH	MH	MH
CHEROKEE	--	H	MH	MH	MACON	H	MH	MH	MH
CHILTON	H	H	MH	MH	MADISON	H	H	MH	MH
CHOCTAW	H	H	MH	MH	MARENGO	H	H	MH	MH
CLARKE	H	H	MH	MH	MARION	H	H	MH	MH
CLAY	--	H	MH	MH	MARSHALL	H	MH	MH	MH
CLEBURNE	--	H	MH	MH	MOBILE	H	H	MH	MH
COFFEE	H	H	MH	MH	MONROE	H	H	MH	MH
COLBERT	H	H	MH	MH	MONTGOMERY	H	MH	MH	MH
CONECUH	H	H	MH	MH	MORGAN	H	H	MH	MH
COOSA	--	H	MH	MH	PERRY	--	H	MH	MH
COVINGTON	H	H	MH	MH	PICKENS	H	H	MH	MH
CRENSHAW	H	H	MH	MH	PIKE	H	MH	MH	MH
CULLMAN	--	H	MH	MH	RANDOLPH	H	H	MH	MH
DALE	H	MH	MH	MH	RUSSELL	H	MH	MH	M
DALLAS	H	MH	MH	MH	SHELBY	--	H	MH	MH
DE KALB	--	H	MH	MH	ST CLAIR	--	H	MH	MH
ELMORE	H	H	MH	MH	SUMTER	H	H	MH	MH
ESCAMBIA	H	H	MH	MH	TALLADEGA	--	H	MH	MH
ETOWAH	--	H	MH	MH	TALLAPOOSA	H	H	MH	MH
FAYETTE	H	H	MH	MH	TUSCALOOSA	H	H	MH	MH
FRANKLIN	H	H	MH	MH	WALKER	--	H	MH	MH
GENEVA	H	MH	MH	MH	WASHINGTON	H	H	MH	MH
GREENE	H	H	MH	MH	WILCOX	H	H	MH	MH
HALE	H	H	MH	MH	WINSTON	--	H	MH	MH
HENRY	H	MH	MH	MH					

Table 2. Nitrogen (N) management criteria for row crops, forage and pastures, based on Alabama Cooperative Extension System recommendations.

Crop	Type	Right Rate	Right Time	Additional Information
Row Crops				
Canola			Apply 40 to 50 lb of N near planting in the fall, apply 90 to 120 lb N in February just prior to crop bolting.	If canola follows a good legume in the fall (peanuts or soybean), reduce the fall N application to 20 lb per acre.
		160 lb/ac		
Corn				
	Non- Irrigated	120 lb/ac	Apply 25% to 50% of N near planting and side dress the remainder when plants are about knee-high.	
	Irrigated	200 lb/ac		
	Silage	200 lb/ac		
Corn rate per unit yield				
	Non- Irrigated	1 lb/bu up to 120 bu any amt. over 120 bu will have a rate of 1.25 lb/bu	Apply 25% to 50% of N near planting and side dress the remainder when plants are about knee-high.	
	Irrigated			
	Silage	10 lb/ton		
Cotton			Apply N near planting; or 20 to 30% near planting and side dress the remainder prior to early square bloom.	On land where excessive growth causes a problem reduce N rate by 20 to 30 lb/ac; when vegetative growth has been inadequate increase N rate by 20 to 30 lb/ac.
		90 lb/ac		
Peanuts			N is not required for legumes.	N in the form of manure/litter can be applied to peanuts up to a rate of 100 lb/ac available N near planting.
		0 lb/ac		
Small Grains			Apply 20 lb/ac N near planting and 60 to 80 lb/ac N at Feeke's growth stage 4 for south Alabama and growth stage 4-6 for north Alabama.	If a small grain is following a heavily fertilized corn crop, a good peanut or soybean crop, or a drought-damaged crop that could not utilize all the fertilizer N applied, often no fall N will be needed.
	Harvest Grain	100 lb/ac		
	Cover Crops	30 lb/ac	Apply 30 lb/ac N near planting	

Row Crops (cont.)				
Small Grains rate per unit yield			Apply 20 lb/ac N near planting and the remainder at Feeke's growth stage 4 for south Alabama and growth stage 4-6 for north Alabama	
	Barley	1.4 lb/Bu		
	Oats	1.0 lb/Bu		
	Rye	1.7 lb/Bu		
	Wheat	1.7 lb/Bu		
Sorghum			Apply 25% to 50% of N near planting and side dress the remainder approximately 30 after planting.	
	Grain	80 lb/ac		
	Silage	200 lb/ac		
	Sweet	80 lb/ac		
Sorghum rate per unit yield			Apply 25% to 50% of N near planting and side dress the remainder approximately 30 after planting.	
	Grain	2 lb/cwt		
	Silage	10 lb/ton		
Soybean				N in the form of manure/litter can be applied to soybeans equal to the estimated N removal in harvested plant biomass near planting.
		0 lb/ac	N is not required for legumes.	
Pasture and Forage Crops				
Alfalfa				N in the form of manure/litter can be applied to legumes equal to the estimated N removal in harvested plant biomass as growth begins.
		0 lb/ac	N is not required for legumes.	
Annual Legumes				N in the form of manure/litter can be applied to legumes equal to the estimated N removal in harvested plant biomass as growth begins.
Arrowleaf clover, ball clover, crimson clover, caley peas, lespedeza and vetch		0 lb/ac	N is not required for legumes.	
Bermuda or Bahiagrass Hay			Apply 100 lb/ac as growth begins in spring and after each cutting up to September 1, or apply 50 pounds N per ton of anticipated hay removed in the next cutting.	
Improved varieties		100 lb/ac/cutting		
Bermuda or Bahiagrass Hay per unit yield				
Improved varieties		50 lb/ton		

Pasture and Forage Crops (cont.)				
Cool Season Annual Grasses			For planting made in early September, apply 100 pounds of N per acre near planting and 60 pounds per acre in early spring.	If planted in late fall, apply 60 pounds of N per acre near planting and 60 pounds per acre in early spring. Ryegrass planted alone for grazing should receive no more than 60 pounds of N in the fall and up to 100 pounds N in the early spring
	Pasture or Hay	160 lb/ac		
Cool Season Annual Grasses rate per unit yield			For planting made in early fall, apply 60% of the N near planting and the remainder in early spring.	
	Pasture or Hay	50 lb/ton		
Cool Season Annual Grasses with legumes			Apply 60 lb/ac N near planting. If legumes make up at least 50% of the ground cover in late winter or early spring do not apply additional N.	
		60 lb/ac		
Cool Season Perennial grass				
	Pasture	120 lb/ac	Apply 60 lb/ac N around September 1st and 60 lb/ac in February	
Cool Season Perennial Grasses rate per unit yield			Apply 40 lb N/ton of anticipated yield in February.	If forage is needed in fall for grazing apply up to 60 lb/ac N around September 1st. For hay 35 lb of additional K2O per ton of anticipated yield may be needed.
	Hay	40 lb/ton		
Cool Season Perennial grass with legumes			Do not apply N if legumes make up 33% or more of the ground cover.	If legumes do not make up 30% of ground cover apply 60 lb/ac N around September and 60 lb/ac in February
	Pasture	0 lb/ac		
Sericea Lespedeza			N is not required for legumes.	N in the form of manure/litter can be applied to legumes equal to the estimated N removal in harvested plant biomass as growth begins.
		0 lb/ac		

Pasture and Forage Crops (cont.)				
Warm Season Annual grass			Apply 60 lbs/ac of N in spring before growth begins and an additional 60 lbs/ac of N after each hay cutting or after each time the forage is grazed down up to September 1	
	Pasture or Hay	60 lb/ac/cutting or grazing period		
Warm Season Annual Grasses rate per unit yield			Apply N rate per yield for expected yield in spring before growth begins and an additional N rate per yield for expected yield after hay cutting or after each time the forage is grazed down up to September 1	For hay 35 lb of additional K2O per ton of anticipated yield may be needed.
	Hay	40 lb/ton		
Warm Season Perennial grass			Apply 60 lbs/ac of N in spring before growth begins and an additional 60 lbs/ac of N when more growth is needed up to September 1	
	Pasture	60 lb/ac/grazing period		
Warm Season Perennial grass with perennial or late maturing legume			If legume makes up 33 percent or more of the stand, do not apply N. Apply 60 pounds of N per acre if legumes do not makes up 33 percent and extra growth is needed.	
		0 lb/ac		