TECHNICAL NOTES

U S Department of Agriculture Natural Resources Conservation Service

AGRONOMY - 14

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Winter Period Application of Manure in Washington State

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Introduction

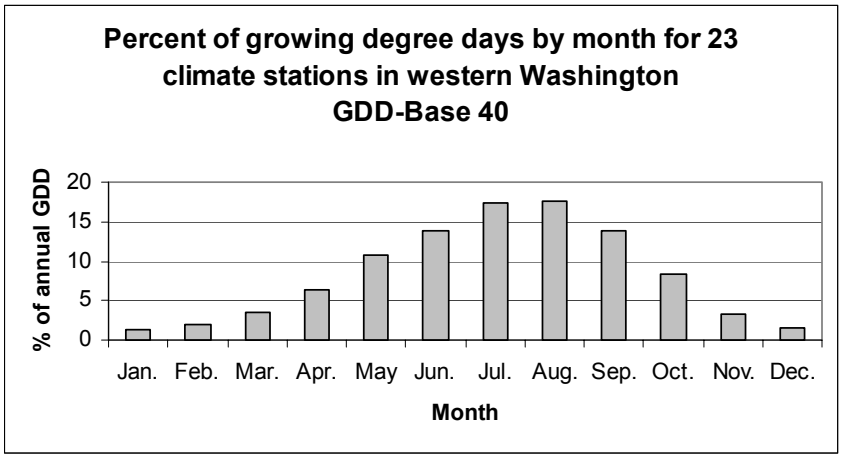
Application of manure to cropland is intended to provide nutrients for crop growth and improve soil quality. Early spring application, TSUM 200 [i], is traditionally the start of annual manure applications for most nutrient management plans. During this time period, growth of perennial pasture, silage and hay crops is rapid and the demand for nutrients exceeds supply. Manure applications continue through the summer and into the fall. Manure applications generally stop after Oct 1 due to increased risk of contaminants moving to surface and ground water along with a decline in crop nutrient demand. The planned storage requirement for each operation is dependent on the planned timing of manure applications and amount of manure materials generated at each operation.

Nutrient Management practice standard 590 is defined as "Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments". The timing of manure applications shall "correspond as closely as possible to plant nutrient uptake characteristics, crop system limitations, current soil and water limitation risk assessment, weather, climate and field accessibility". One general criteria in 590 for all purposes is a risk assessment process to evaluate the risk of applied nutrients and associated contaminants moving to surface and/or groundwater. Application of manure during the "winter period", defined as October 1 – March 1, must meet appropriate criteria listed in 590 including proper timing and risk assessment.

Manure applications to provide nutrients while minimizing risk of contaminating surface and ground water are part of a nutrient budget. A crop specific nutrient budget for Nitrogen (N), Phosphorous (P) and Potassium (K) is required for all nutrient management plans. The nutrient budget, when using manure, accounts for realistic yield goals, available nutrients from all sources and plant available nutrients from the source of manure. Creating and maintaining each budget requires a consistent soil and manure sampling schedule along with realistic yield goals. Figure 1 shows an average of 21% of annual growth and nutrient requirement for perennial cool season grass pastures in Western Washington can occur during the winter period. The unique climate and crop growth characteristics of each livestock operation across Washington influence the ability of the planner to match nutrient application as close as possible to nutrient uptake. In many areas, crop growth, plant maintenance and nutrient uptake continues during the winter period.

Each manure application provides a potential for contaminants including Nitrogen, Phosphorous and fecal bacteria to move into surface and/or ground water, which is unacceptable. There are areas and livestock operations in the State of Washington that have the unique combination of manure qualities, climate, soil and crop systems that may allow application of manure during the winter period. Developing an accurate nutrient budget, performing complete risk assessments and recognizing other site and application limitations determines the feasibility of manure application during the "winter period" for each specific field. Stakeholders involved with manure application to cropland in Washington have requested guidance for application of manure during the winter period and have provided input through workgroup sessions.

Figure 1. Washington Climate Summary (http://www.wrcc.dri.edu/summary/climsmwa.html)



Purpose

The purpose of this technical note is to provide guidance for applications of manure during the winter period (October 1 through February 28) that minimize risk of contaminants moving to surface and ground water.

1. Define the characteristics of manure producing operations and crop systems that might allow winter period applications.

2. Define the risk assessment procedures and mitigation measures necessary to prevent contamination of surface and ground water due to manure applications during winter period.

3. Define the use of nutrient budget components to determine practical rates and timing for winter period manure applications.

4. Define the site characteristics and soil conditions that do not permit winter period application.

General Requirements for application during the winter period:

All manure applications must meet the appropriate criteria listed in Nutrient Management 590 and Waste Utilization 633 practice standards. (eFOTG; Section IV).

Planned and actual application timing of manure during the winter period will be documented in the approved nutrient management plan.

Winter period applications are only intended for established perennial vegetation producing greater than 50% of the production potential for the soil based on Soils and Pasture or hay land/Silage Production Potential Estimation Sheet. (eFOTG; Section II)

Nutrient management plans will contain a map that delineates the planned and actual application areas, existing soils, surface water and existing conservation practices in place at the time of manure applications.

Risk Assessment:

Each soil mapping unit within each field boundary must be evaluated and site investigations performed if needed to confirm soil mapping.

Fall Soil Nitrate test analysis and evaluation. (Sullivan and Cogger, 2003)

Current Phosphorous Index evaluation. (WQ-Technical Note 2. 2001).

Soil Limitation analysis using soil survey data base. (Soil Data Mart)

Soil erosion estimates using current erosion prediction technology. (RUSLE2, 2005) (WEQ, 2005)

Limitations based on risk assessment:

Manure applications during the winter period are **not** allowed where:

1. Field areas with a Fall Soil Nitrate test greater than 60 lb NO3/acre
2. Field areas with a Phosphorous Index of High or Very High
3. Field areas with an estimated soil loss greater than planned soil loss tolerance T.
4. When soil and site limitations exist for soils within a planned application area and the limitation cannot be mitigated to a low risk with conservation practices and management activities, the soil map unit area will not to be used for manure applications during the period that the limitation is present.

Limitations based on Climatic, site and operation characteristics:

Manure applications during the winter period are **not** allowed where:

5. Soil that is frozen[ii] , ponded[iii] or saturated[iv] on the day of application.
6. Soils where actual flooding is expected to occur during or immediately following the application.
7. Greater than 0.5 inch rain is expected within 24 hours following applications.
8. Field areas with slopes greater than 8% unless movement of surface water is controlled.

Nutrient Budget:

Nutrient Budget must include realistic annual yield goals and associated estimates of nutrient requirements for N, P and K. Nutrient removal for specified crops and yields will be based on estimated values contained in Chapter 6, Ag Waste Management Field handbook. (AWMFH) Yield goals for plans using winter period application include estimated yield from date of fall soil nitrate evaluation to the next years fall soil nitrate test evaluation.

Nutrient Budget must include a representative “current” soil sample result for N, P, K, pH, OM, and EC collected according to the planned sampling schedule. A current Phosphorous index is calculated from each current soil test P value for each field. Estimated nitrogen mineralization of soil organic matter is included in the nutrient budget.

Nutrient Budget must include a current manure test analysis to estimate plant available N, P and K contained in the organic material. The initial manure test will be a laboratory analysis based on a sample taken within 60 days of the first winter period application. Additional testing of manure may be used to fine tune application rates throughout the year. Nitrogen meters, hydrometer tests and laboratory analysis are acceptable methods. A common schedule is 3 samples per year collected during early fall, early spring and mid summer. Manure analysis will include measures of Organic N, NH4 and NO3 to estimate Plant Available Nitrogen from manure.

The nutrient budget and plan must include a Fall Soil Nitrate test and evaluation each year. This test is intended to review the previous year's nutrient budget and evaluate changes in application plan and nutrient budget to be considered. Soil test NO3 available at this time will be included in the nutrient budget. The annual nutrient budget for the crop year begins after the Fall Soil Nitrate test sampling date. Annual planned yield goals and estimated nutrient requirements includes estimated growth after the fall nitrate test date and the primary growing season.

Winter Period Application Specifications

Rate

1. Applications will not exceed 33% of the annual planned manure applications.
2. Plant available nitrogen from manure applied during winter period will not exceed 100 lb/ac.
3. Individual applications will not exceed 20% of the annual planned manure applications.
4. The example below describes the process of determining agronomic rates for winter period applications.

Timing

1. Do not apply on the same field area more than once every 4 weeks.
2. Do not apply manure when expected irrigation, rain, melting snow, flooding or wind will cause offsite movement or the infiltration rate of the soil is exceeded.

Method

1. Application equipment will be calibrated and capable of applying the prescribed rates and placement of manure.
2. Applied manure solids will not physically cover greater than 25% of the leaf surface of the existing crop.
3. Maximum application rate of liquid forms of manure per application will not exceed 0.25 acre inches.
4. Application setbacks from surface water and wells that are required will be doubled and consist of established perennial vegetation.

Storage

1. At a minimum, storage is needed for periods when precipitation or soil conditions do not allow manure applications.

Example:
Planned manure applications using winter period application timing:

Soil and site limitations have been evaluated and the risks of leaching and runoff are mitigated

Phosphorous Index risk assessment rating is LOW.

Nutrient management budget will balance to Nitrogen needs.

Soil erosion estimate using WEQ and Rusle2 is less than planned soil loss tolerance T.

Current Fall Soil Nitrate test = 25 lb/ac carryover NO3 on September 25.

Estimated annual soil organic matter mineralization is 25 lb/ac.

Planned crop is established perennial cool season grass for hay and silage

Planned Nitrogen requirement for planned crop is 50 lb N / ton

Form of manure is liquid from lagoon for dairy operation

- Estimated no leaching loss during all application periods for this example
- Estimated no loss to volatilization for applied manure during winter period
- Estimated volatilization loss during spring and summer applications = 25%

Plant available nitrogen estimate from manure test and annual application schedule is:

- Available Organic N for current year = 18 lb N/1000 gal
- NH4-N = 6 lb/1000 gal; NO3-N = 0 lb/1000 gal
- Plant available N from manure = 24 lb N/1000 gal

Plant nutrient availability from manure is based on an as applied basis.

Example Continued: Planned manure applications using winter period application timing

Rates of nitrogen applications during **Winter Period for 4 yield goals**

Yield Goal (Tons/acre - air dry basis)	3	4	5	6
Plant Nitrogen Uptake (lb/ton)	50	50	50	50
Total N requirement (lb/ac)	150	200	250	300
Soil test nitrate available (lb/ac)	25	25	25	25
Winter period (lb available N/ac) *	42	58	75	91

- * Winter N application = 0.33 * (Total N requirement – Fall soil nitrate)

Rates of nitrogen applications during remaining crop year for 4 yield goals

Yield Goal (Tons/acre - air dry basis)	3	4	5	6
Plant nitrogen uptake (lb N/ton)	50	50	50	50
Total N requirement (lb N/ac)	150	200	250	300
Soil test nitrate available (lb/ac)	25	25	25	25
Winter N applications (lb N/ac)	42	58	75	91
Soil OM – N mineralization (lb N/ac)	25	25	25	25
Other credits (includes commercial fertilizers)	0	0	0	0
Remaining N applications (lb N/ac)	58	92	125	159

Example Summary:

Rates of Manure Applications: Winter Period and remaining crop year

Yield Goal (Tons/acre - air dry basis)	3	4	5	6
Winter period N applications (lb N/ac)	42	58	75	91
Winter period manure applications (gal/acre) *	1750	2417	3125	3922
Remaining N applications (lb N/ac)	58	92	125	159
Remaining manure applications (gal/ac)	2417	3833	5208	6625
Remaining effective applications (gal/ac) **	3223	5111	6944	8833

- * Estimated plant available N from manure for example is 24 lb / 1000 gal
- ** Remaining crop year application efficiency estimate is 75% due to estimated volatilization loss

References

Kowalenko, C.G., et. al., 1989. An evaluation of the T-Sum method for efficient timing of spring nitrogen applications on forage production in south coastal British Columbia. Can. J. Plant Sci. 69:1179-1192.

Pirelli, G. et. al., 2004. Early Spring Forage Production for Western Oregon Pastures. EM 8852-E. Oregon State University Cooperative Extension.

Sullivan, D.M. & C.G. Cogger. 2003. Post-Harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades. EM8832-E. Oregon State University Cooperative Extension.

eFOTG, 2005. Washinton State - Field Office Technical Guide. Sections I-V. USDA-NRCS, Washington State. http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=WA

AWMFH Agricultural Waste Management Field Handbook: National Engineering Handbook, Part 651. USDA-NRCS. Washington, D.C. http://www.wcc.nrcs.usda.gov/awm/awmfh.html

WQ-Technical Note 2. 2001. The Phosphorus Index, USDA-NRCS Washington State. eFOTG; Section II. http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=WA

RUSLE2, 2005. Revised Universal Soil Loss Equation Version 2. USDA-NRCS, Washington, DC. http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm

WEQ, 2005. Wind Erosion Equation. USDA-NRCS, Washington, DC. http://www.weru.ksu.edu/nrcs/

Soil Data Mart. http://www.soildatamart.nrcs.usda.gov/

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[i] ***T-Sum 200***: *Date when the sum of the mean daily air temperatures in degrees Celsius from January 1 reaches a value of 200. Equivalent T-sum value using degrees Fahrenheit would be approximately 395.* **(Kowalenko, C.G., et. al., 1989) (Pirelli, G., et. al., 2004)**

[ii] ***Frozen soils***: *three inches of soil or more within the top 12 inches of soil is at or below 32 degrees F*

[iii] ***Ponded soils***: *standing water is on the soil surface during the application period. Soils that pond may have slow permeability, high water table and/or sealing of the surface*

[iv] ***Saturated soils***: *soil pores are saturated and little or no oxygen is present. This condition is usually caused by slow permeability, shallow water table and/or restrictive soil horizons*