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Soils (Part 2): Sources of Organic Nutrients

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under grant number 2013-51106-21663.

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Sources of Organic Nutrients

I. Legumes and green manures
II. Animal manures
III. Compost
IV. Processed fertilizers
V. Micronutrients and other amendments

Legume Crops

- Fix nitrogen from atmosphere
  - *Rhizobium* inoculation will ensure nodulation and N fixation
- Include green manure, grain, and forage crops

Legume Crops

- Grain crops (net N contribution will vary)
  - Soybean
  - Pea
  - Dry bean
- Cover crops and forages
  - Vetch
  - Clover
  - Alfalfa
  - Native legumes

Field pea

Hairy vetch

Alfalfa

Are Your Legumes Fixing Nitrogen?

1. Dig up a plant that is over 1 month old, but not flowering
2. Remove soil from roots
3. Look for nodules on the roots
4. Actively-fixing nodules appear pink or red inside

Factors Affecting N Contribution from Legumes

- Biomass production
  - Affected by species, stand density, weed competition, stand age
- Biomass composition
  - Carbon:Nitrogen (C:N) ratio depends on crop maturity

Factors Affecting N Contribution from Legumes

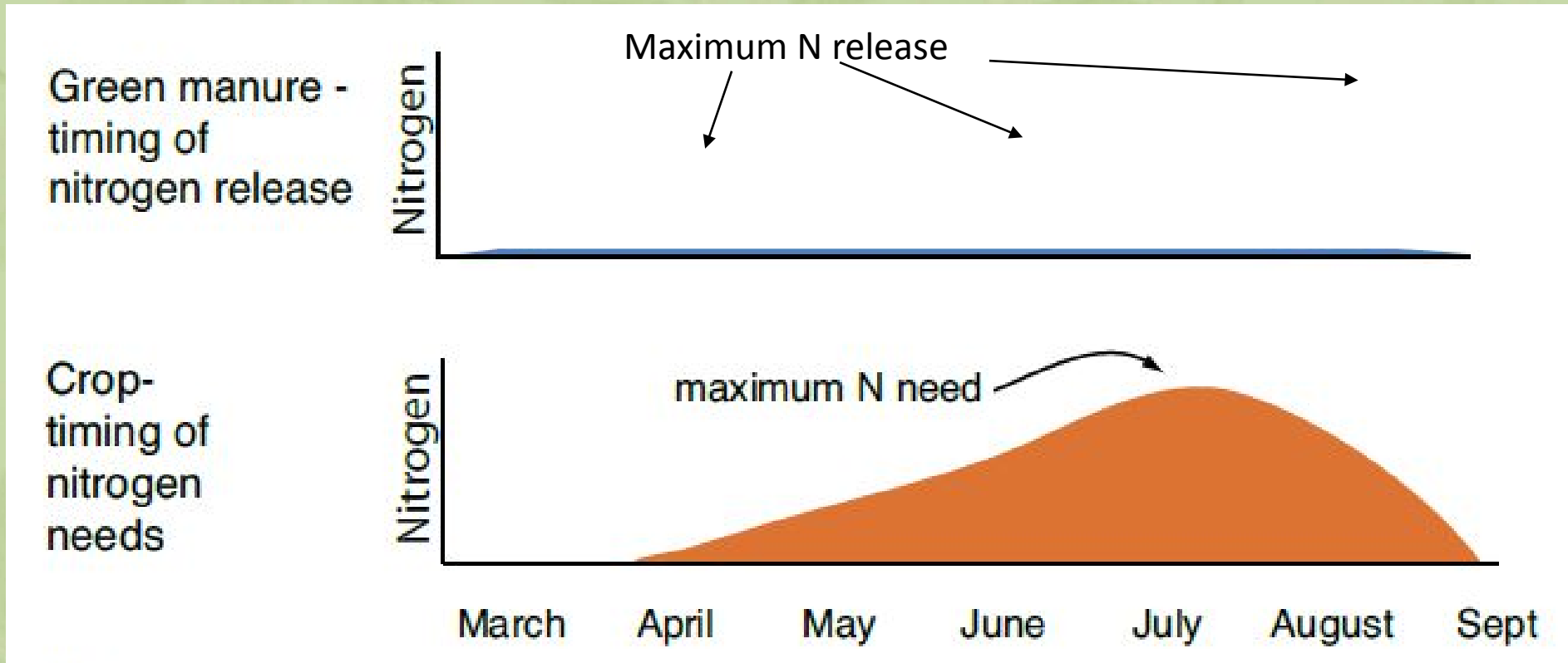
- Harvest regime
  - Number and timing of cuttings
  - Biomass removal
- Method and timing of incorporation

Nitrogen Release and Loss

- Decomposition rates depend on soil temperature, moisture, biology
- Can be lost to denitrification

Crop Access to Legume N

Availability may not be synchronous with crop need (feed the soil!)



N Credits from Legumes

Reduction in fertilizer need of following crop (recommendations developed for conventional agriculture)

Crop	N credit (lb/A) to first-year corn*
Alfalfa	
1 year old stand	75
2+ year old stand	150
Red or alsike clover	75
Grass/legume hay	75
Field peas or dry beans	20
*On medium-textured soils	

Source: Kaiser et al., 2016

Non-Legume Green Manures

- Do not fix N, but can hold nutrients for later release
- Contribute to soil organic matter and microbial activity
- Decomposition of high C:N crops can immobilize N

Carbon to Nitrogen Ratios of Organic Materials

Material	C:N Ratio
Oat straw	70:1
Rye cover crop (anthesis)	37:1
Pea straw	29:1
Mature alfalfa hay	25:1
Ideal Microbial Diet	24:1
Young alfalfa hay	13:1
Hairy vetch cover crop	11:1

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Raw Animal Manures: Summary

- May be solid or liquid
- Hog, dairy/beef, poultry, other
- Need not be from organic sources
- Additional testing may be required for conventional manure

Raw Animal Manures: Application

- Cannot apply to frozen ground
- Application times restricted for food safety

Crop	Permitted application
Feed crops	Anytime
Food crops with edible portion not in contact with soil (e.g. corn)	≥90 days before harvest
Food crops with edible portion in contact with soil (e.g. carrots)	≥120 days before harvest

Typical nutrient content of stored manure

		N	P_2O_5	K_2O	N	P_2O5	K_2O
		pounds/1000 gallons			pounds/ton		
Swine	Farrowing	27	27	15	-	-	-
	Nursery	34	25	18	-	-	-
	Gestation	40	42	18	22	27	14
	Finishing	53	39	29	22	22	17
Dairy	Cows	25	15	27	11	7	9
	Heifers	-	-	-	13	12	19
Beef	Cows	-	-	-	15	10	9
	Steers	-	-	-	14	9	14
Poultry	Turkeys	-	-	-	44	63	34
	Broiler	-	-	-	59	63	40
	Layer	-	-	-	39	57	30

Adapted from UMN Extension

Determining Manure Application Rates

1. Establish nutrient needs of the crop
   - Apply credits from legumes or previous manure applications
2. Determine the nutrient content of manure
3. Determine nutrient availability to crop
4. Calculate rate of application

See worksheet and reference tables in Resources section of this unit

% Nitrogen Available over Time and Manure Type (Sweep Application)

Manure Type	Year 1	Year 2	Year 3
Beef Cattle	60	25	10
Dairy Cattle	55	25	15
Swine	80	15	0

Raw Animal Manures: Considerations

- Be aware of contaminants
  - Certifier may require heavy metals testing
- Be careful with flow control to ensure uniform application and desired rate

Broadcast manure application

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Making Compost

- Various base materials
  - Manure
  - Bedding
  - Plant materials
- Methods include windrow, static pile, and in-vessel
- Must follow guidelines for composting manure

Guidelines for Organic Compost

- Initial C:N ratio between 40:1 and 25:1
- For contained systems or static aerated piles: temperatures must remain between 131° and 170° F for 3 days
- For windrow systems: temperatures must remain between 131° and 170° F for 15 days and windrow must be turned 5 times in that period

John McQueen, eOrganic

Applying Compost

- No organic restrictions on timing of application
  - State environmental laws may apply
- Incorporate to allow microbial breakdown
- Manure not composted according to guidelines will need to follow application rules for raw manure

Nutrient Availability from Compost

- Generally lower nutrient content than raw manure
  - Meeting N needs may result in excess P, salt, other ions
- 30% or less of N available in first year
  - Will depend on base material and composting method

Composted turkey manure

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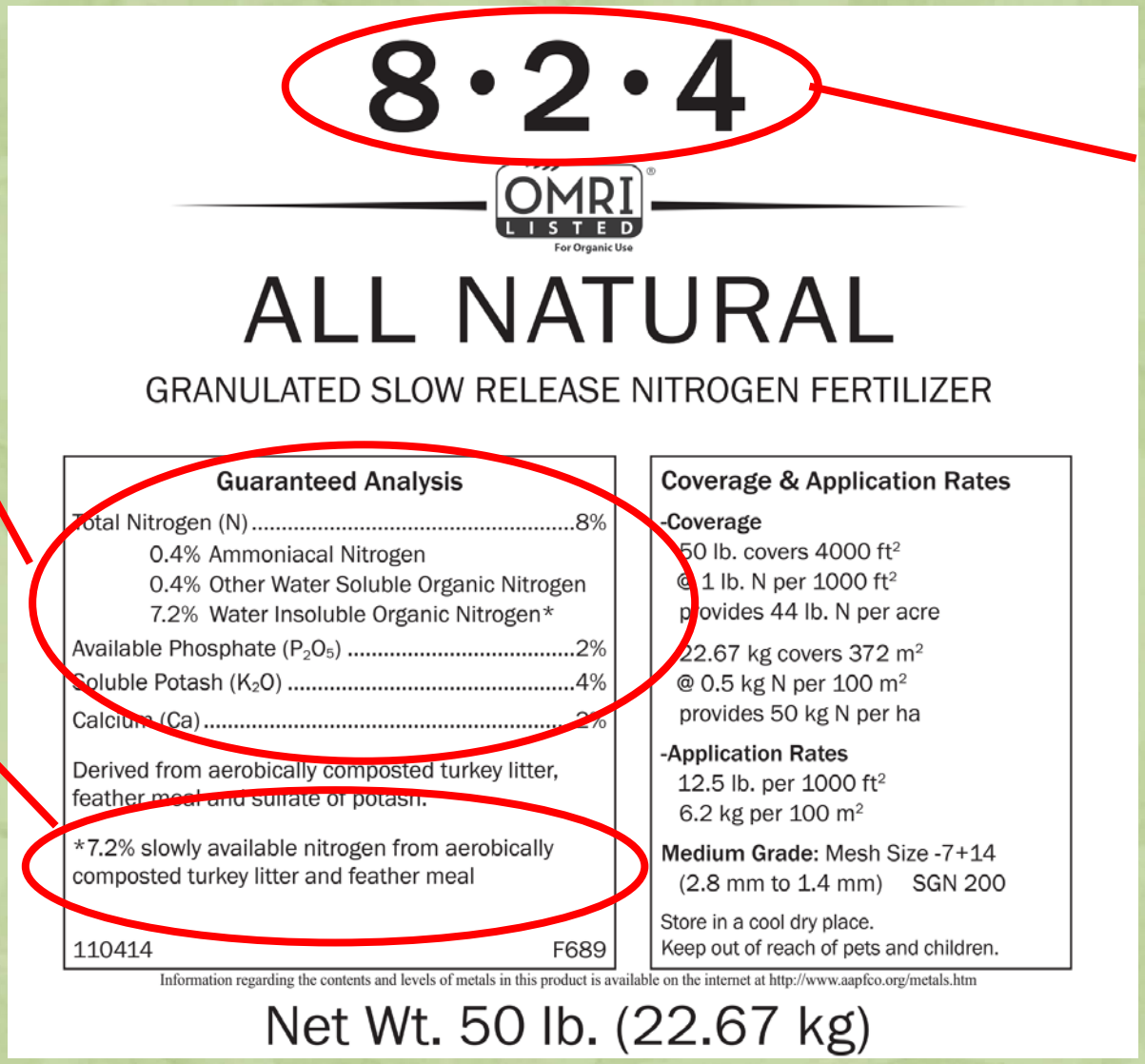
Commercial Fertilizers

- Fish products
- Heat treated manure products
- Sodium nitrate (Chilean nitrate)
- Bagged/blended formulations
  - May contain feather or blood meal, fish or aquatic plant extracts, humic acids

How to Read a Fertilizer Label



% nitrogen-phosphorus-potassium (N-P-K) by weight

Amounts and chemical forms of nutrients present

Percentage of slow release nitrogen

Commercial Fertilizers: Considerations

- Check OMRI lists for organic status of products
- Apply as directed, within organic guidelines
- Some effects may be similar to conventional
  - Highly available (soluble) nutrients
  - Vulnerable to leaching and loss
  - May reduce pH

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Micronutrient Amendments

- Some synthetics are allowed
  - Need documentation of deficiency from soil or tissue test
- Apply at rates recommended in test results
- Check in with certifier!

Other Products and Practices

- "Magic bullets" you may hear about
  - Base-Cation Saturation Ratio
  - Fungal:bacterial ratio
  - Inoculant products (other than *Rhizobium*)
- Many sales pitches use scientific language, but are NOT supported by published, peer-reviewed research

Other Products and Practices

- Not all products are reputable
  - Be wary of paying $$ for undocumented benefits
  - Seek guidance from Extension, certifier, experienced growers
- If it seems too good to be true, it probably is!

Summary

- **Rotation is your main tool**
- **Use permitted plant- and animal-based nutrient sources**
- **Check with your certifier!**

Resources

- National List of allowed and prohibited substances for organic farming
- List of manure testing labs – Minnesota Department of Agriculture
- Field soil sampling instructions – University of Minnesota
- Worksheet for calculating manure application – University of Minnesota
- Composting instructions – eXtension
- Organic Production Guide – ATTRA
- Guide to permitted inputs – NRCS
- Can I Use this Input on My Organic Farm? – eXtension

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