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Department of
LAND, AIR AND WATER RESOURCES
University of California, Davis
Climate Change • Sustainable Agriculture
Environmental Quality • Landscape Processes

Nitrogen Mineralization from Organic Fertilizers and Composts

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Irrigation and Nutrient Management Meeting
August 31, 2022

Plant available N in soil

Residual soil nitrate:

- Directly available form of N.
- Origin:
  - Mineralization of organic N in spring
  - Left over fertilizer N from previous crop

Potentially available N:

- Nitrogen mineralized during the season from soil organic matter and other sources

Organic sources in soil

- Soil organic matter
- Crop residues, cover crops
- Organic amendments
- Manure, lagoon water

Nitrogen pools and turnover in soil

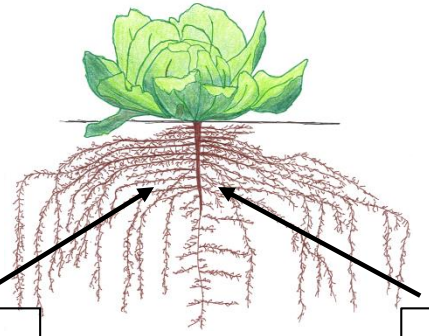
Organic N

Mineralization by soil microbes

Ammonium (NH_4^+)

Ammonia (NH_3)

Volatili-zation



Nitrification

Nitrate (NO_3^-)

N_2, N_2O

Denitrifi-cation

Soil microbes

Leaching

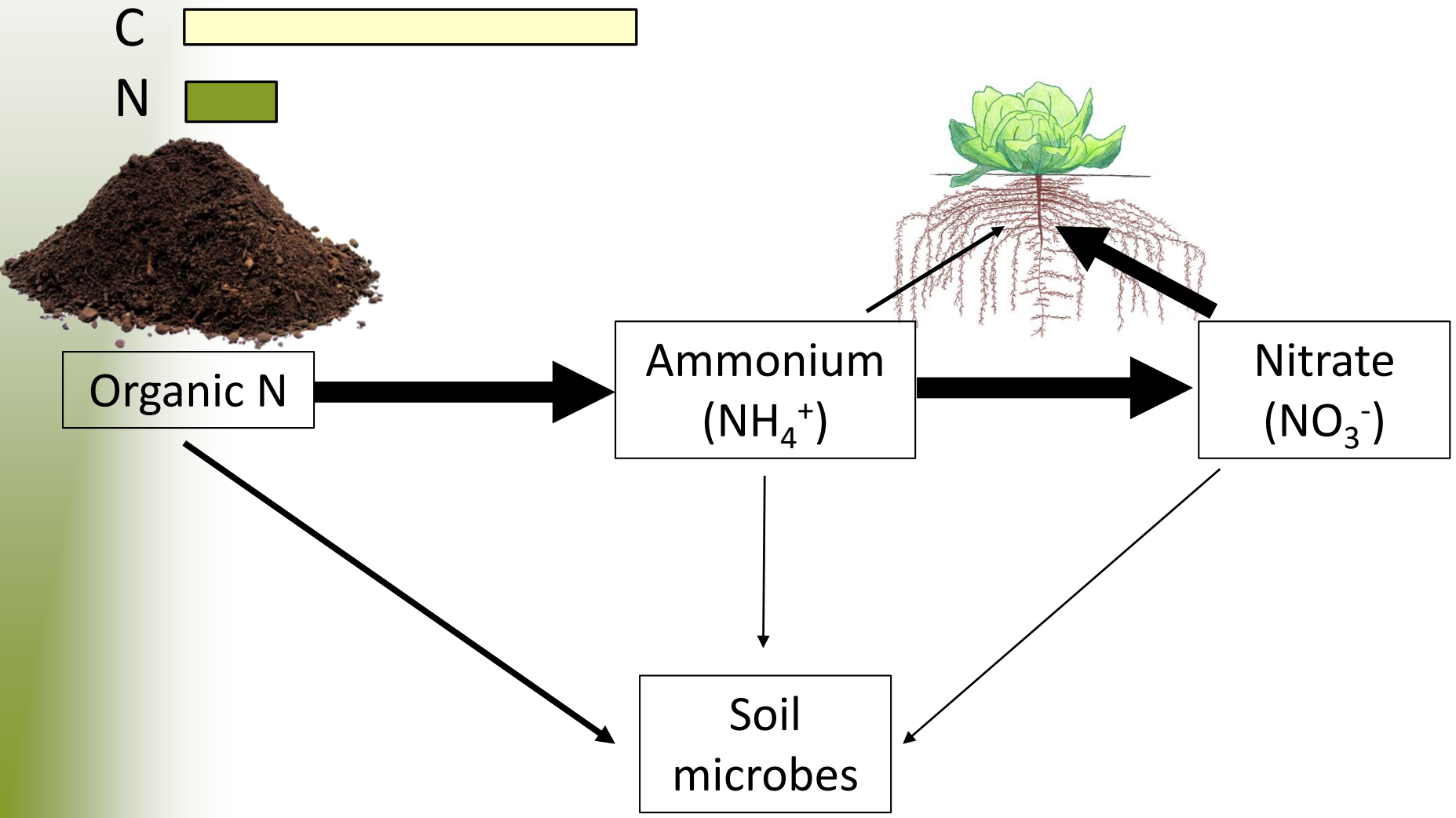
Factors affecting decomposition and N mineralization

- Soil temperature
- Soil moisture
- Quality of organic source
  - Nitrogen content
  - C to N ratio
  - Availability of C and N
- Management

Nitrogen mineralization

- Soil microorganisms decompose residue
- Need N and C as building blocks for their own biomass
- C is also used as energy source
- **N mineralization:** Release excess N in the form of NH_4^+ into soil solution
- **N immobilization:** Uptake of NO_3^- or NH_4^+ from soil solution and incorporation into microbial tissue

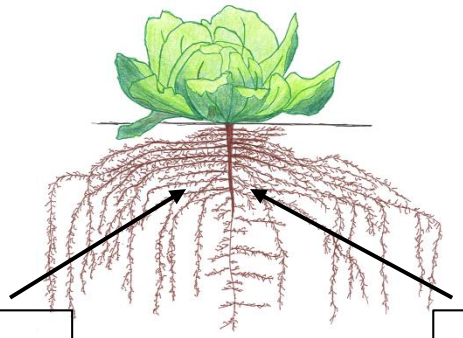
Nitrogen turnover in soil



Nitrogen turnover in soil

C

N



Organic N

Ammonium (NH_4^+)

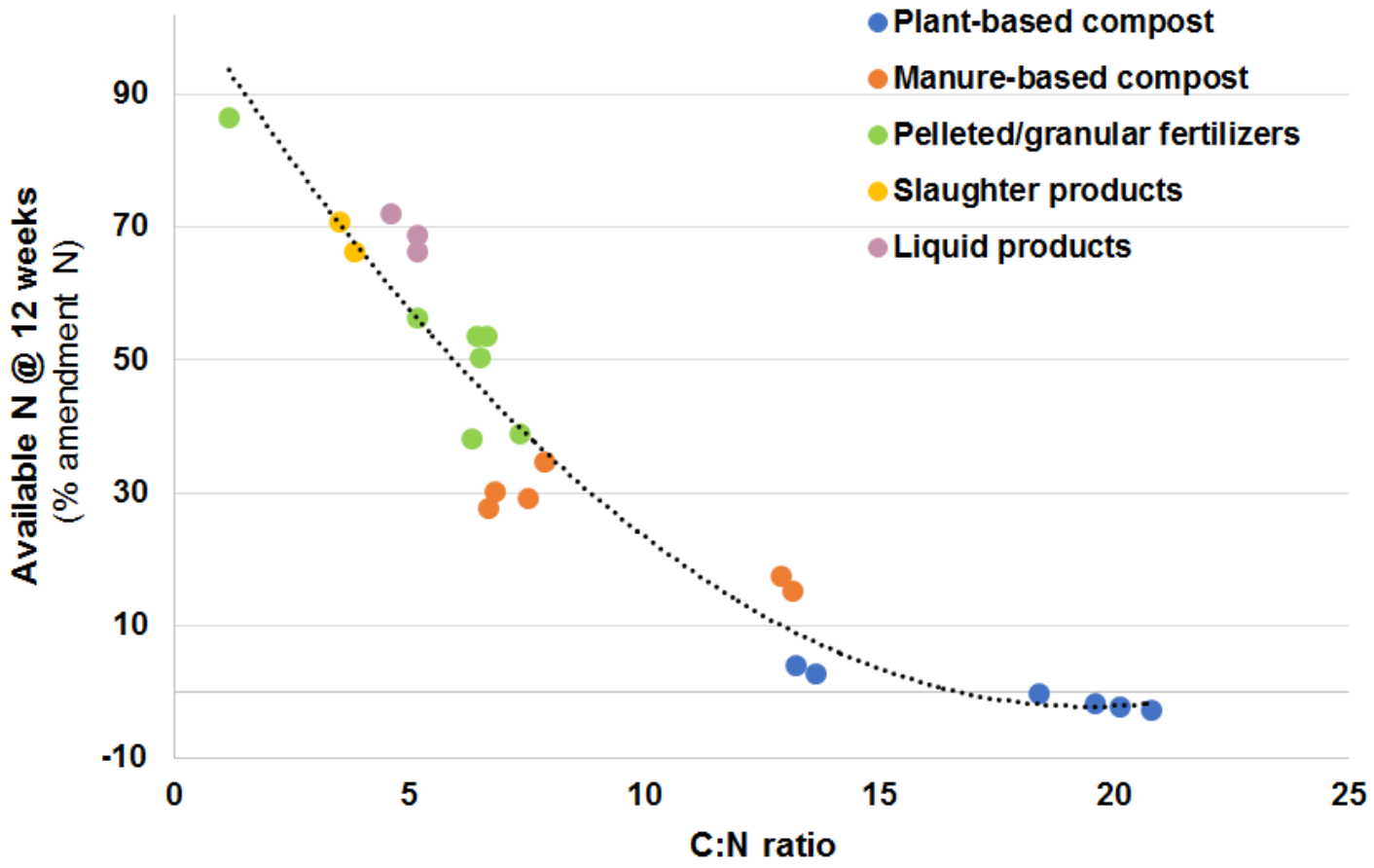
Nitrate (NO_3^-)

Soil microbes

Amendment incubation

- Materials sold in California
- Incorporated into moist soil
- Constant temperature 73 °F
- 12-week incubation

Effect of C to N ratio on N release



Lazicki et al., 2020

Open questions

- Can we describe N mineralization over time with equations that can be used in decision support tools?
- How variable are different groups of amendments?

⇨Need a bigger dataset

Our approach

- Compiled data from the literature
- Used model to simulate net N mineralization at 77 °F and optimal moisture

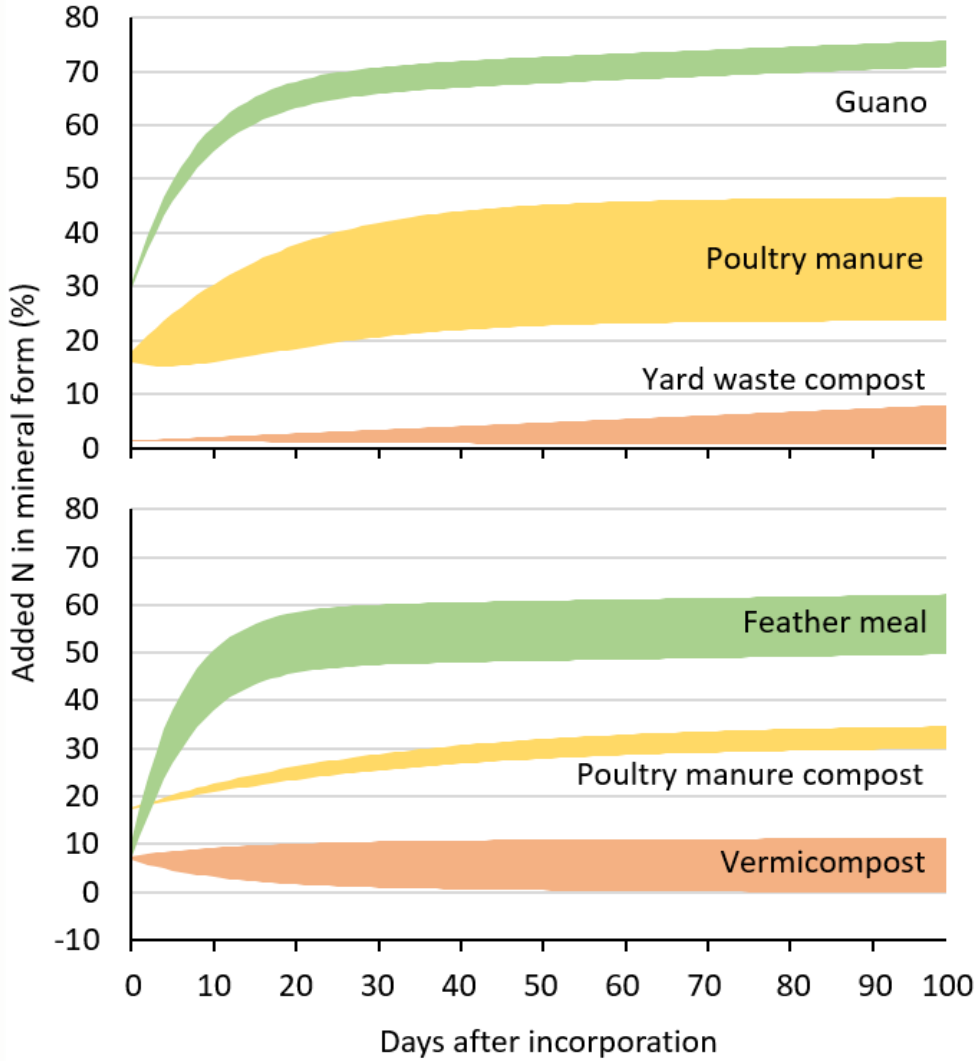
Why use a model?

- Studies differed with respect to
  - Temperature
  - Duration

The dataset

Material	Studies	Datasets	Observations	C to N ratio in dataset		
				Average	Min	Max
Guano	4	8	44	2.8	1.2	3.8
Feather meal	7	14	70	4.0	3.3	10.0
Poultry manure	9	29	195	10.3	6.3	19.5
Poultry manure compost	4	16	77	7.3	5.7	9.4
Vermicompost	8	21	125	11.1	14.9	35.0
Yard waste compost	6	25	126	16.1	9.1	22.3

Nitrogen mineralization from organic amendments



Based on 113 datasets from the scientific literature

Net N mineralization rates

After 100 days - at 77 °F

- optimal moisture

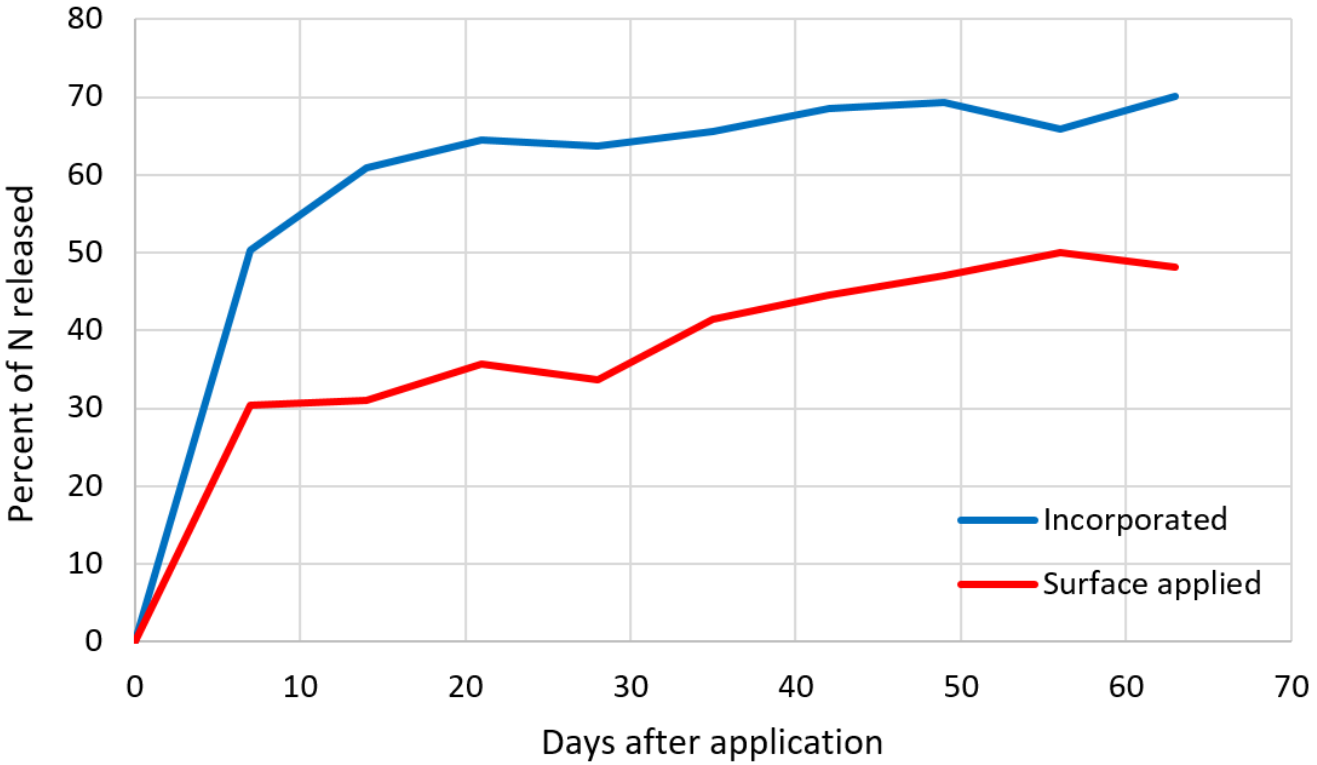
Material	Net N mineralization (% of N added)		
	Average	Min	Max
Guano	72.5	70.6	75.5
Feather meal	60.9	49.7	62.2
Poultry manure	39.6	23.7	46.6
Poultry manure compost	32.7	30.0	34.6
Vermicompost	9.5	-0.2	11.3
Yard waste compost	4.2	0.7	8.0

Factors taken into account in online tool

- ✓ Soil temperature
- ✗ Soil moisture ⇨ Assumes moist soil
- ✓ Quality of organic source
  - Nitrogen content
  - C to N ratio
  - Availability of C and N
- ✗ Management ⇨ Assumes incorporation

Management effects

Application of a pelleted organic fertilizer (4-4-2 ⇨ 4% N, 4% P_2O_5, 2% K_2O)



Source: Richard Smith

The online tool

http://geisseler.ucdavis.edu/Amendment_Calculator.html

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Geisseler Lab

Nutrient Management

Nitrogen Mineralization from Organic Amendments

The calculations in this tool are based on an analysis of 113 datasets from the scientific literature. Nitrogen mineralization rates are adjusted based on soil temperature data from local CIMIS weather stations. Soil moisture is assumed to be optimal near field capacity. **When amendments are incorporated into dry soil, N mineralization would be slower than calculated. The tool should not be used when amendments are left on the soil surface.**

Information on lines marked with an * needs to be provided. If no information on amendment and soil properties are entered, the tool will use average values. In this case, however, the calculations will be less accurate for a specific situation.

The online tool

Input

Amendment Application

Region*:	Sacramento Valley - Yolo	
Type of amendment*:	Feather meal	
Application rate*:	1	tons/ac
Application date*:	04 / 01 / 2021	
Period of interest:	6 Months	
Depth of incorporation*:	8	inches

* Required input.

Amendment Properties

Amendment dry matter:	95	%
Total nitrogen:	14.5	% in dry matter
Carbon to nitrogen ratio:	4	
Mineral nitrogen: (ammonium and nitrate)	0.06	% in dry matter

Soil Properties

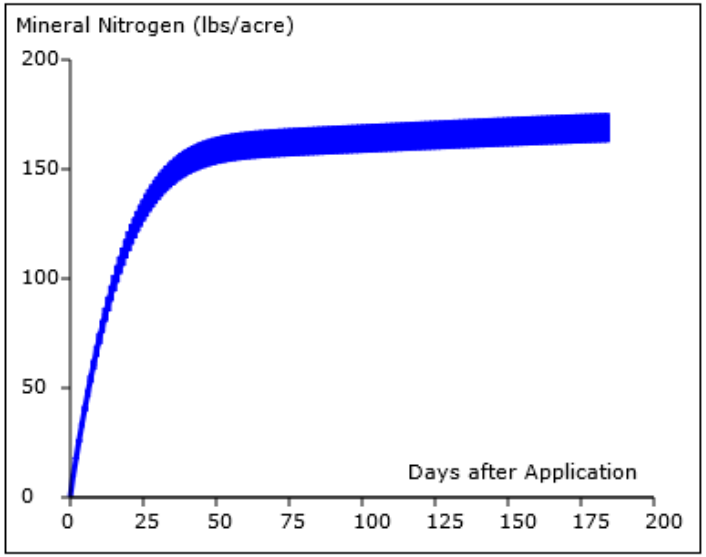
Soil organic matter:	3	%
Residual soil nitrate:	10	ppm Nitrate-N

Display Results/Changes

The online tool

Output: Feather meal, 1 t/ac

Nitrogen Mineralization



The graph and the calculations are based on average values from scientific studies. Weather conditions, soil properties, amendment characteristics and management all can affect N mineralization rates. It is therefore **important to monitor N availability of the field with soil or leaf analyses**. More information about soil and leaf sampling can be found here.

Total N applied:	276 lb/ac
Total mineral N applied:	1.3 lb/ac
Estimated available N:	162 - 176 lb/ac
Percent available:	59 - 64 %

The online tool

Output: Poultry manure, spring vs. fall

Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

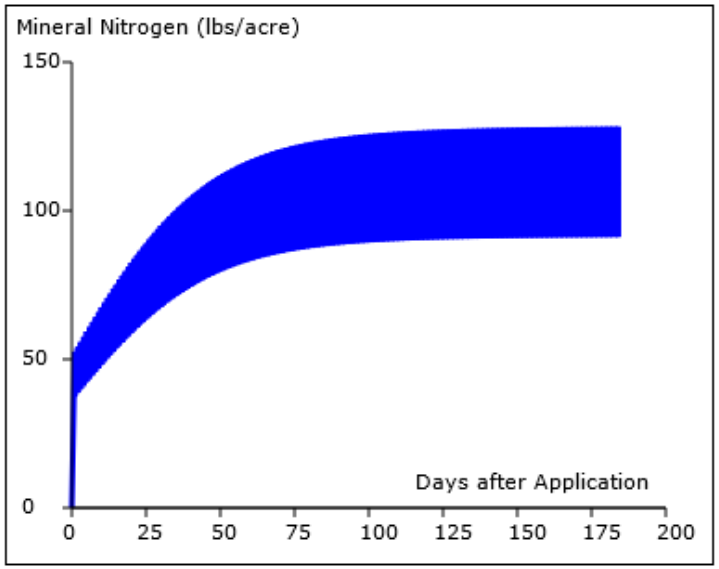
Application date*: 06 / 01 / 2022

Period of interest: 6 Months

Depth of incorporation*: 6 inches

* Required input.

Nitrogen Mineralization



Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

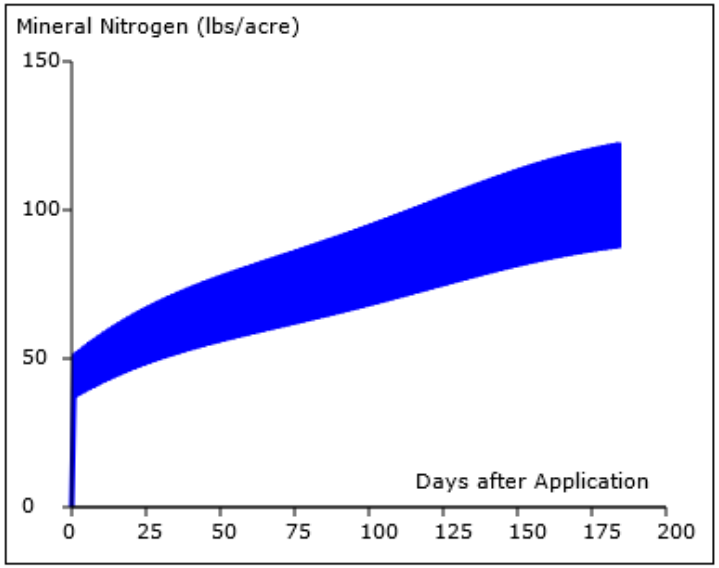
Application date*: 12 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 6 inches

* Required input.

Nitrogen Mineralization



The online tool

Output: Poultry manure, Sacramento vs. Ventura

Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

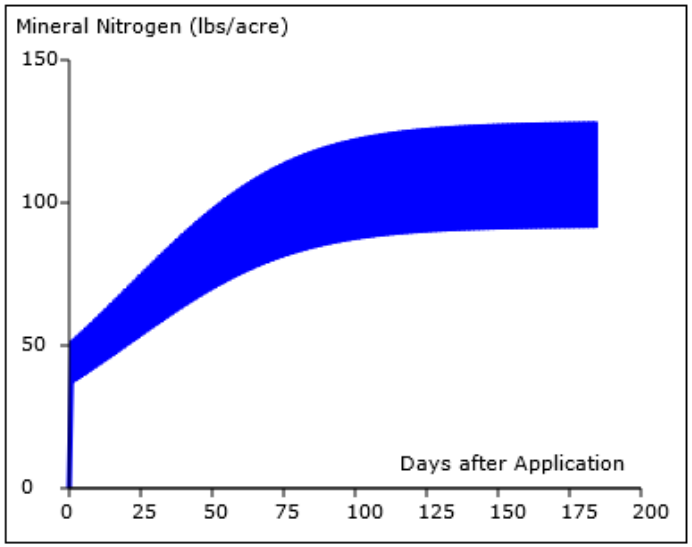
Application date*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Nitrogen Mineralization



Amendment Application

Region*: Central Coast - Ventura

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

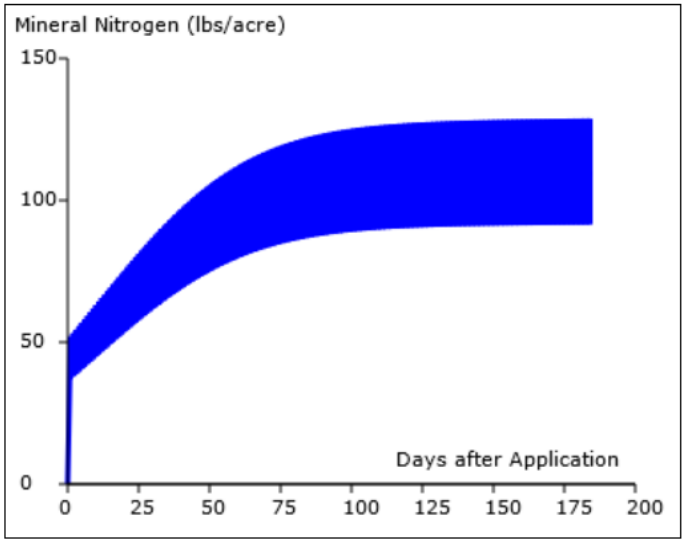
Application date*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Nitrogen Mineralization



Conclusions

- N availability differs considerably across organic amendment types
- The C:N ratio can be used to estimate N mineralization
- Different batches of the same amendment can vary considerably
- It is important to monitor the N status of the crops in the field during the growing season

Acknowledgement

- CDFA Specialty Crops Block Grant Program
- CDFA Fertilizer Research and Education Program (FREP)
- Joji Muramoto, Richard Smith, Mike Cahn, Margaret Lloyd
- Patricia Lazicki

Organic amendments:
The online tool

http://geisseler.ucdavis.edu/Amendment_Calculator.html