# Maximizing Nitrogen and Other Nutrients In Cover Crop Systems

## June 22, 2016

# Agenda

- How much N is fixed by cover crops & when can it be expected for the next cash crop
- Maximizing N production & understanding N mineralization
- Role of inoculants in cover crops & why they are important
- Managing Nitrogen in cover crops for forage

# Predicting Nitrogen Delivery

# Nitrogen Fixing Differences in Legumes

- Crimson Clover 70 – 150 lbs.
- Balansa Clover 60 – 100 lbs.
- Berseem Clover 60 – 120 lbs.
- Red Clover 70 – 150 lbs.
- Hairy Vetch 90 – 180 lbs.
- Winter Peas 90 – 150 lbs.
- Sunn Hemp 80 – 125 lbs. (summer/early fall)
- Cowpeas/Field Peas 90 – 150 lbs. (summer/early fall)

Harvesting plant for grain and/or forage removes a HUGE portion of the N that was fixed. However, over half the harvested N can be recovered with the right cropping and/or livestock system.

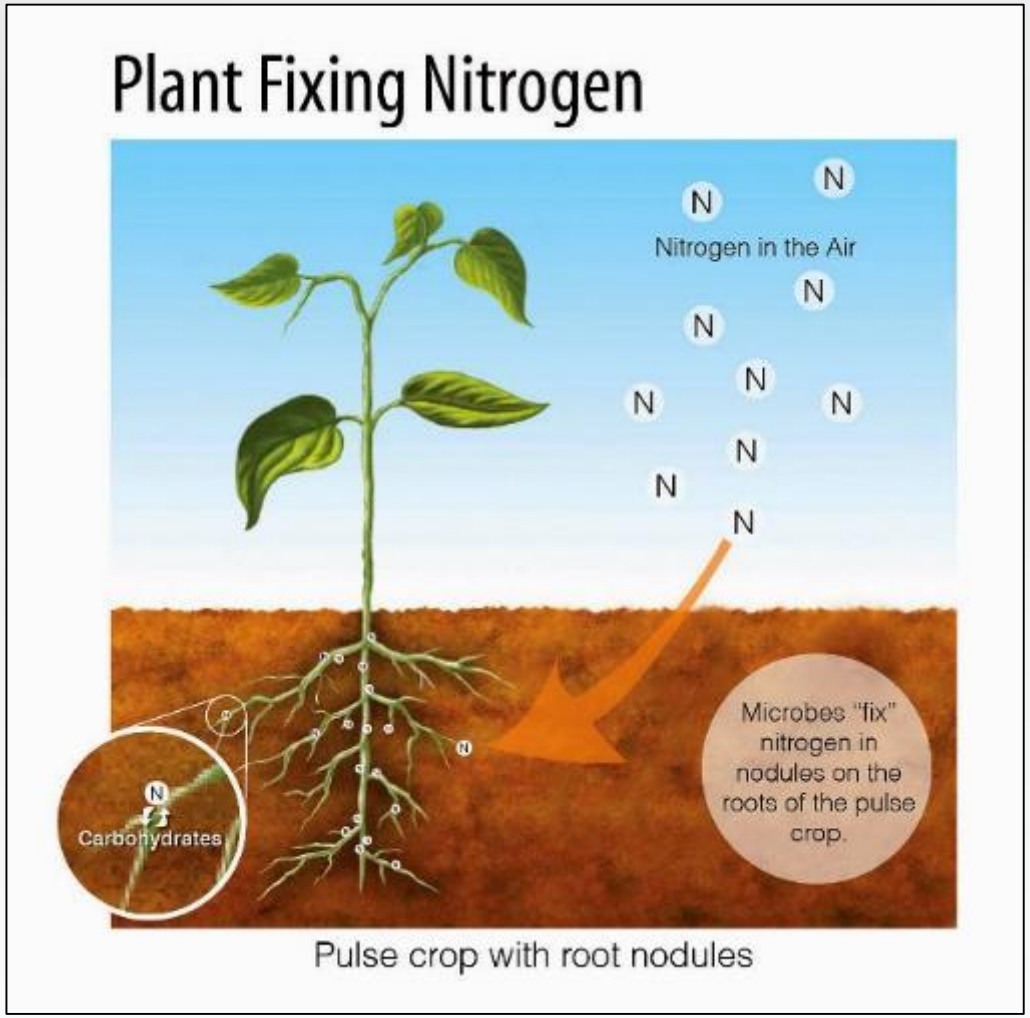
**Assume only 50% of this N will be available.**

These estimates assume biomass is maximized and growing conditions for these legumes are matched agronomically to their growing season. Many variables exist that affect N production (including when these species are terminated)….this is only a guide.

*SOURCE: Penn State University, Colorado State University, Kansas State University*

# Nitrogen Fixation Factors

- The rate of N fixation related to plant growth
- - Plant Growth = - N fixation understanding N mineralization
  - Drought
  - Disease
  - Potash availability
  - Low temperatures
    - 55°- 80°F optimum



Pulse crop with root nodules

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# Plant Available Nitrogen (PAN)

- PAN control by C:N ratio
- Legumes provide up to 100 lbs PAN, but must be terminated at **bud stage** to maximize production
- Cereals immobilize up to 50 lbs PAN
- Total N as a % of Dry Matter is a good predictor of PAN

  ≥ 3.5% N in DM = at least 35 lbs PAN / ton of DM

  (1% N in DM = 10-20 lbs PAN / dry ton)
- Most PAN released 4-8 weeks after cover crop kill

# Estimating Plant Available Nitrogen Release

| % N in DM | LBS N/DM Ton | 4 wks PAN/DM Ton | 10 wks PAN/DM Ton |
|---|---|---|---|
| 1.0 | 20 | <0 | 0 |
| 1.5 | 30 | 3 | 9 |
| 2.0 | 40 | 7 | 14 |
| 2.5 | 50 | 12 | 20 |
| 3.0 | 60 | 19 | 28 |
| 3.5 | 70 | 28 | 37 |

*Taken from Oregon State University (Predicting PAN from Cover Crops), 2012*

# Estimating Plant Available Nitrogen Release

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| 1.0 (rye) | 20 | <0 | 0 |
| 1.5 | 30 | 3 | 9 |
| 2.0 | 40 | 7 | 14 |
| 2.5 | 50 | 12 | 20 |
| 3.0 | 60 | 19 | 28 |
| 3.5 (peas) | 70 | 28 | 37 |

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# Typical N Contributions

| Cover Crop | % N in DM (early spring) |
|---|---|
| Annual Ryegrass | .5 – 1.0 |
| Cereal Rye | .9 – 1.4 |
| Winter Wheat | .9 – 1.4 |
| Crimson Clover | 1.5 – 2.4 |
| Red Clover | 1.9 – 2.8 |
| Hairy Vetch | 2.5 – 3.5 |
| Winter Pea | 2.5 – 3.5 |
| Rapeseed | .8 – 1.5 |
| Spring Oats | .7 – 1.2 |

*Estimates taken from Pacific Northwest (cover crop seeded in Sept. and measured in April). Actual N concentrations will greatly depending on region, temperature, and rainfall; and the maturity and condition of the cover crop)*

# Cover Crops Should Match Desired C:N Ratio

| Material | C:N Ratio |
|---|---|
| rye straw | 82:1 |
| wheat straw | 80:1 |
| oat straw | 70:1 |
| corn stover | 57:1 |
| rye cover crop (anthesis) | 37:1 |
| rye cover crop (vegetative) | 26:1 |
| mature alfalfa hay | 25:1 |
| Balanced Microbial Diet | 24:1 |
| rotted barnyard manure | 20:1 |
| daikon radish | 19:1 |
| legume hay | 17:1 |
| beef manure | 17:1 |
| ryegrass (vegetative) | 15:1 |
| young alfalfa hay | 13:1 |
| hairy vetch | 11:1 |
| soil microbes (average) | 8:1 |

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# Cover Crops Should Match Desired C:N Ratio

## Why is the C:N Ratio Important?

- C:N ratios >24:1 often need added N for the following cash crop, depending on the crop. Residues added to the soil with a greater ratio will likely result in a temporary **nitrogen deficit (immobilization)**
- Species with a C:N ratio lower than 24:1 will result in a temporary **nitrogen surplus (mineralization)**

# Cover Crops Should Match Desired C:N Ratio

## Why is the C:N Ratio Important?

- The larger the C:N ratio, the slower the decomposition rate, meaning N & other nutrients could be tied up if not managed properly
- Terminating grass cover crops in the vegetative stage is recommended when going to a high-N use crop like corn or sorghum

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# Planting Corn After Small Grain Cover Crop

- Many people attribute inhibition in corn growth by rye to allelopathy *(release of chemicals by one plant inhibiting growth of adjacent plants)*
- Typically rye residues on the soil surface are responsible for weed suppression rather than release of phytotoxic chemicals
- Research shows susceptibility to allelochemicals is indirectly related to seed size — the smaller the seed the more susceptible the plant.
  - Larger corn seed and its deeper planting depth - ???

***Reference: Hartzler, Iowa State***

# Planting Corn After Small Grain Cover Crop

**Several factors may be involved (vs. blaming allelopathy)**

- Presence of rye mulch on soil surface alters soil environment in a way that inhibits corn growth. Mulch may delay soil warming & drying, creating a less favorable environment for corn.
- Rye may act as ‘green bridge’ for plant pathogens. Dying rye can serve as host for pathogens that move to corn seedlings after rye dies.
- Decaying rye biomass will tie up soil N

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# Inoculating Cover Crop Legumes

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- Rhizobia bacteria inoculants are crucial to allowing legume to fix large N amounts
  - Without correct rhizobia present, the legume won't maximize N production, and maximum benefit for corn or grass cash crop won't be achieved
- Cover crop legumes need rhizobia, and if we do not have the proper background population in the soil, we must inoculate
- Most common cover crop legumes, including winter peas, crimson clover, winter hairy vetch and sunn hemp, do not have a viable option to "pre-inoculate" (like alfalfa/red clover)
  - Rhizobium that nodulates alfalfa can survive on seed >2 years; In many cases other strains don't survive on seed >24 hrs.
- Beware of "pre-inoculated" cover crop seed
  - In most cases, there will not be any surviving rhizobia

# Inoculating Cover Crop Legumes

Life span of the strains needed to properly inoculate:

- Soybeans – liquid inoculants that contain extenders are good past 120 days
  - Sterile peat products are good for 30 days
  - Standard planter box product would be 2-4 days
- Alfalfa / Red Clover - Alfalfa clay pre-inoculants are good for 2 years
  - Clover clay pre-inoculants would be 1 year
  - Peat-based planter box products = 48 hours max
- Crimson Clover – pre-inoculants = 48 hours max
- Hairy Vetch – planter box treatments = 12-24 hours max
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# Inoculating Cover Crop Legumes

- For max N production, it's recommended to add fresh inoculant to seed at time of planting
- Each legume requires a certain strain to nodulate properly
  - The strain that nodulates red clover won't nodulate crimson clover
  - Peas/vetches/sunn hemp require their own specific strains
  - Leftover soybean/alfalfa inoculant won't work in cover crops
- Products are now available that make inoculating all cover crop legumes much easier and more complete

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Cover Crops as Forage

# Cover Crops as Forage

- No better way to make cover crops pay (in 1st year) than to feed them
- Practically anything can be fed
- Important to match goal to product
  - What & when you want to use will determine the best forage option(s)
- Addition of cereal grains makes sense (simple + tonnage)
- If maximizing biomass is the goal, then everything should be done to achieve it
  - Planting date
  - Ideal use of forage (silage vs. balage vs. pasture/grazing)
  - Understand the fertility needed

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# Cereal Grains for Spring Forage

- **Wheat**
  - Higher in quality than rye, triticale and oats, but not barley
  - Produces more dry matter than barley
    - **BEST USE** – Spring Pasture; Silage (boot to dough stage); Hay (boot to milk stage)
- **Fall Triticale**
  - Best suited for grazing pasture
  - Because of large stems, hay wilting & silage packing is difficult
    - **BEST USE** – Spring Pasture; Silage & Hay (boot to dough stage)
- **Winter Barley**
  - Value as a silage crop is comparable to whole - plant corn
    - **BEST USE** – Silage & Hay (boot to dough stage)
- **Cereal Rye**
  - Greatest production for hay or pasture ground due to quick growth in spring
    - **BEST USE** – Spring Pasture

Chopping Fall Rye in May in Illinois

# Fertility Needed by Typical Cover Crops

- Wheat/Rye as Silage (Removal Rates)
  - Equivalent 60 bushel yield crop
    - 80-100# N
    - 40# P
    - 60-70# K
- Oats
  - Equivalent 80 bushel yield crop
    - 70-90# N
    - 30# P
    - 100# K
- Brassicas – will respond favorably to additional N & P
    - 30-40# of N

# Forage Sorghums / Summer Annuals

- Ideal for filling summer gap (i.e., after wheat harvest)
- Perfect option when situations dictate earlier seeding (i.e., prevent plant)
- Take advantage of heat & dry weather
  (and get tonnage when cool season forages are dormant)
- Maximize tonnage & biomass in short amount of time
- Many Options:
  - Forage Sorghums (1 Cut) & Sorghum Sudangrass (Multiple Cuttings)
  - Sudangrass (Quicker dry-down for dry hay possibilities)
  - Pearl Millet (Grazing option from summer into fall – no prussic acid)
- SUMMER ANNUALS REQUIRE ADDITIONAL MANAGEMENT (especially N)
  - Forage sorghums need approx. 1.25# actual N / day

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# Managing Elevated Nitrate Levels in Forage

- Expect nitrate levels to be higher whenever excess fertility is present and/or manure applications have recently been made
- When manure or fertilizer applications are followed by period of stress on a plant (i.e., drought/frost), nitrate can rise to levels that may take several weeks to dissipate
- Unfortunately, most cover crops can be susceptible to elevated levels of nitrates
  - Rye, oats, summer annuals, radish, turnips, rapeseed

# Managing Elevated Nitrate Levels in Forage

Common sense can greatly reduce probability of nitrate issues:

- Nitrates are concentrated more in lower stalk
  - Raising cutting height can reduce risk
- Cut plants retain nitrate levels
  - Best to leave plant in field & test forage until levels have subsided
- Feedstuffs high in carbohydrates (like grain) help reduce effects of nitrates
- When stressful drought precedes moisture event, delay harvest 1-2 weeks
- Consider split applications of N
- Expose livestock slowly over several days into suspected pasture
- Always provide plenty high carb forage
- TEST forage if problem anticipated

# Manure Matters Too

Numerous work from Iowa, Pennsylvania, Canada, etc.

- Cover crops can reduce $N_2O$ emissions and soil inorganic N losses when manure is applied
- Small grains alongside manures have increasingly been showing their ability to decrease $NO_3$ losses in drainage water
- Other covers being utilized alongside hog, poultry, and cattle (dairy) manures
  - Annual ryegrass – very tolerant to swine manure
  - Clovers (crimson, red, berseem)
  - Brassicas (radish, turnips)
- MSU testing manure slurry seeding methods since for over 10 years with very positive results

# Questions?

# Thank You for your time!

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